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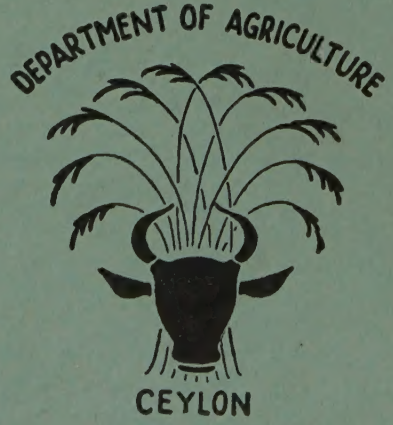

VOLUME CX
NUMBER 1
JANUARY TO MARCH 1954

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TROPICAL AGRICULTURIST

Volume 110 January-March, 1954 Number 1

Published Quarterly By

DEPARTMENT OF AGRICULTURE
PERADENIYA, CEYLON

Subscription Rates

(*Inclusive of Postage*)

	Annual	*Single copy*
Local	Rs. 5·00	1·50
India, Burma and Pakistan	Rs. 6·50	2·00
Abroad	Rs. 8·00	2·25

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Registered as a newspaper in Ceylon.

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EDITORIAL

Agricultural Mechanization in Ceylon

TRIALS with the mechanized cultivation of coconut lands were carried out in Ceylon as early as 1920 with the different makes of tractors then available, notably the old Fordson and the Cletrac, but no further advances in this field were made until comparatively recently. During the last War some tractors were imported from the U.S.A. for agricultural purposes and as a result of the experience gained with their use on both paddy land and arable highland, a large number were subsequently obtained for extensive mechanized cultivation. Contributing largely to this development were the striking results of an experiment carried out by A. L. Johnpulle with the tractor cultivation of 203 acres of paddy land in the Eastern Province in 1943-44 and the large-scale demonstration of the economic cultivation of no less than 7,000 acres of paddy land in the Kalmunai District of the Eastern Province in 1946-47 *.

The main advantage of the mechanical tillage of paddy land under our dry zone conditions is that it permits of the cultivation of a much larger acreage within the short period when ideal soil moisture conditions prevail than is possible with animal-drawn implements. Thus in these areas where labour is in short supply, buffaloes or other draft animals often difficult to obtain in adequate numbers, and the time within which to prepare paddy land for cultivation limited, mechanization is the only solution to the problem of extensive and timely cultivation. In addition, tractor cultivation is more economical than animal tillage if conditions are not abnormal. A further advantage of farm mechanization which is of great consequence in the intensively developed countries of the world where land is a severely limiting factor, is that for every animal displaced about 2½ acres of land are released for the production of human food.

In order to study effectively the problems of agricultural mechanization, an Agricultural Engineering Division of the Department of Agriculture was started in 1945. Included among its functions was the conduct of investigational work on power machinery from the technical and economic aspects, the demonstration of their use on a pilot scale, and the designing of implements suited for local usage. From small beginnings the Division has grown very appreciably in regard to its scope, activity and personnel. Once the economics of tractor cultivation was demonstrated, the Division was entrusted with the establishment of six tractor units

* A Note on the Factors Affecting the Economic Use of Tractors in Ploughing and Harrowing Paddy Land. N. J. L. Jansz, *Tropical Agriculturist,* Vol. CIV, No. 2, 1948.

at suitable locations in the country for the purpose of undertaking the cultivation of private and Government paddy lands at a moderate rate—originally fixed at the price of 3 bushels of paddy for each acre of land ploughed and harrowed. The demand for this custom work grew rapidly and no less than 18,000 acres of land were cultivated under this Scheme in 1952. The success of the scheme was largely due to the introduction of a type of tractor that permitted the use of mounted implements. These tractors have greater manoeuvrability as compared with those that pull trailing implements and are better suited for use on our relatively small fields.

There are, however, certain limiting factors which prevent the rapid development of tractor tillage in the country. In the first instance much of the new land which is being opened up for paddy is not in a fit state for cultivation by agricultural tractors, being either insufficiently levelled or land from which the stumps have not been removed after it has been cleared. This means a heavy wear and tear on tyres and implements. The proposal has been made that an organization to undertake the work of jungle clearing with heavy tractors so as to render the land suitable for tractor tillage is very essential if food production is seriously to be advanced. This proposal merits the attention of Government. It necessitates, however, the close collaboration of the two Ministries concerned with the questions of land development and food production. A Central Board for Mechanized Agriculture has therefore been suggested as a measure to promote the closer co-operation between Departments in matters of this nature. In the second instance, it is true that a fairly large proportion of paddy land in this country is unsuitable for mechanical tillage either because of the topography rendering the fields too small and/or too narrow, or owing to the undue fragmentation of holdings and divided ownership. There is little one could do about the former, but their co-operative or collective working is the answer to the latter. A further disadvantage of mechanization in Ceylon is that, unlike on farms in temperate countries, the use of tractors is largely seasonal and, at present, restricted mainly to ploughing and harrowing. The difficulty of seasonal cultivation is not insuperable as it should be possible, in most areas at any rate, to utilise tractors for cultivating coconut and other high land when they are not required for working paddy lands. In regard to their use being mainly restricted at present to ploughing and harrowing, experiments conducted by this Department have indicated that threshing can now be economically carried out with rubber-tyred tractors. Reference is invited to an article by Karunaratne and Ellegalla on the subject in the present issue of this Journal. More recent trials have shown that under certain soil conditions tractors can also be utilised for such operations as mudding and levelling of paddy lands with adapted implements, provided water control is effected

and adequate supplies are available. Trials have also been carried out with self-propelled combine harvesters on paddy and other crops, but certain difficulties have been experienced and more work has yet to be done on this aspect of mechanization particularly from the economic angle. These combines can, however, be utilised for winnowing and threshing paddy at appreciably reduced costs compared with those for methods presently adopted. Experimentation on a large scale has, however, demonstrated that operations such as transplanting, drilling and intercultivation of crops like chillies, tobacco and cotton could be successfully and economically undertaken with tractor-mounted machinery. The mowing of certain varieties of paddy and of fodder grasses and pastures can also be carried out by mechanical methods under certain conditions. From an engineering point of view, however, it has been the experience that owing to the high quartz content of our soils there is greater wear of implement parts than in most temperate zone soils. This has made it necessary to hard-face wearing edges of implements with special alloys.

One factor which seriously limits the usefulness of mechanical tillage is the absence of adequate service, spares, and repair facilities. The organizations concerned with the development of tractor tillage in the country have, however, seen to it that these essential requirements are reasonably well supplied. Yet another such factor is the absence of adequate trained personnel to man these tractors and to effect servicing and field repairs. To a large extent these requirements have been met by conducting training classes of various types though these may not have been of the duration considered desirable. But as the present hands gain more experience, this disadvantage will be largely eliminated.

To revert to the present position of tractor tillage in this country. Following on the success which attended the Departmental tractor units in their endeavours to demonstrate the advantage of such cultivation, Government decided to encourage the use of machinery on a large scale. Co-operative Agricultural Production and Sales Societies were given loans to purchase tractors. Over 220 Fordson tractors with power lifts have thus been purchased by various C. A. P. & S. Societies and Unions in the Island. Tractor repair service facilities were provided to some degree by the Agents in various districts where these tractor units were established. But the experience of the tractor units worked by C. A. P. & S. Societies has not been altogether a happy one. While a number of units are working quite successfully, present indications are that for various reasons, among others the lack of technical skill for operation, inadequate supervision, heavy repair bills necessitated by working on unsuitable terrain, etc., a few have shown appreciable losses in working and would need reorganization. On the other hand a number of private parties have

purchased their own tractors and, so far as one can say, most of these have proved economical to their owners.

A landmark in the mechanization history of this country was the recent magnificent gift by the Australian Government of 190 "Farmall" tractors with power-lift implements and necessary spares. These tractors have been assigned to the Food Production Department which has its main station—the Kangaroo Tractor Station—at Anuradhapura, the Agricultural Department—for use on its farms, and the Gal Oya Board. The rates charged by the various organizations for tractor work undertaken for private parties have been more or less standardized and endeavours have been made to prevent overlapping in regard to their areas of operation. It is no exaggeration to say that there are at least 600 agricultural tractors in operation in this country, but whether all of them are being put to the best possible use it is difficult to state.

The problems of the mechanization of paddy lands in Ceylon are not easy, but with the experience gained over more than a decade there is no reason why, as in temperate countries, mechanization should not prove of benefit in the development of a sound and efficient rice economy. The problems of mechanization on our highlands are, however, much more difficult and an important feature of our work at the Maha Illuppalama Agricultural Research Station will be to ascertain how best mechanization can be utilised for the development of a sound rotational system of agriculture in a tropical country where temperature, rainfall, and wind conditions make severe demands on its soil reserves.

CENTENARY OF THE PLANTERS' ASSOCIATION OF CEYLON

The Editor of the Tropical Agriculturist (Director of Agriculture) congratulates the Planters' Association of Ceylon on the occasion of its Centenary this year and thanks the Association and individual members for the co-operation they have extended the Department in furthering the development of Agriculture in the Island during this period. The Department hopefully looks forward to a period of even greater co-operation with the Association in the years to come.

A Brief Survey of Mechanized Agriculture in Ceylon

G. R. W. DIAS

Cultivation Seasons and Zone of Mechanized Farming

TWO cultivation seasons exist in Ceylon, viz., *Yala* and *Maha*. The *Yala* season is from April to September and the *Maha* season begins in October and ends in March. The country can be divided into two zones as Wet and Dry. The rainfall in the Wet Zone is heavy during both seasons whereas in the Dry Zone it is only during the *Maha* season that the North-East Monsoon brings heavy rain. During the *Yala* season, the South-West Monsoon brings much rain to the Wet Zone while very little rain falls in the Dry Zone. It is mostly in the Dry Zone where the annual rainfall ranges from about 37 to 65 inches that mechanized agriculture is carried out. This area roughly falls within a belt ranging from a section of the Southern Province (the South-East), the Eastern Province, Northern Province, North-Central Province and a portion of the Central and North-Western Provinces.

Introduction of Agricultural Tractors and their Maintenance

Agricultural tractors were first imported to the country in numbers somewhere in 1942 for tillage operations such as ploughing and harrowing on State Farms. Since then these farms have been using tractors for their routine cultivation. The servicing and maintenance of these tractors were looked after by the Mechanical Branch of the Irrigation Department until in 1946 a Division of Agricultural Engineering was established within the set-up of the Department of Agriculture. This Division now maintains all the agricultural machinery of the Department in addition to its other duties. Tractors whose B. H. P. vary from 23 to 45 and which are run on petrol, kerosene and diesoline are being used. The types used are the crawler and wheel types. Caterpillar D 4 and D 2, International TD 6, T 6, and W 9, Massey Harris K 30, New Fordson Major and Ferguson TE-A 20 and TE-D 20 are some of the makes and models of agricultural tractors being used in Ceylon at present. Some of these tractors use trailed implements only, whereas others use trailed as well as mounted implements. In the case of state-owned agricultural tractors, spares and service stations are maintained at a few central spots scattered in the Dry Zone. The Main Stores and Workshop are situated at Peradeniya. The cleaning, lubrication and minor adjustments required on the machines, and the replacements and external repairs of the machines are carried out by the tractor operators in the field or at the Field Repair Depots, whereas major repairs are carried out in the Workshop at Peradeniya.

Operating Personnel

The present practice in the Department of Agriculture is to train men with a basic knowledge of agriculture as

drivers for mechanized cultivation. Men with Practical Farm School Certificates selected for training as drivers have shown very good results and their quality and output of work have been far superior to that of drivers without a knowledge of agriculture. Some of the Co-operative Agricultural Production and Sales Societies which own tractors follow this mode of recruitment of tractor drivers, whereas others select men with certificates of competance to drive motor vehicles, and train them as drivers of mechanized cultivation with the assistance of the firms which supply them farm machinery.

Dry Farming

In the Dry Zone, dry farming as opposed to cultivation of crops under irrigable conditions, consists of the cultivation of crops such as maize, sorghum, kurrakkan (Eleusine Corakana), gingelly, cowpea, cotton, dhal, groundnut, tomato, chilli, &c., under rain-fed conditions. A crop of highland paddy is also grown in some areas in the Dry Zone under rain-fed conditions. Most of these crops are grown during the *Maha* season. As time is one of the main factors to be considered in dry farming, the land is prepared for sowing before the onset of the monsoonal showers, which normally fall in October. The age of most of the crops grown is four months or less and the sowing is normally adjusted to suit the variety of crop grown so that harvesting could take place in February-March. Very often the preparatory tillage operations are done in September after an intermonsoonal shower of rain.

The disc plough has proved to be more suitable than the mouldboard plough as even under dry conditions the land could be ploughed with the former. It is very essential to get the land ploughed dry for certain crops like maize and cotton to be sown in time to receive the *Maha* rains. If this is not done, the season for such crops is lost as the heavy rains in *Maha* may make the soil too wet and unfit for tractor cultivation during the rainy period. In some areas it becomes necessary to plough the land in August or early September. One important aspect to be considered in such areas during these months is the prevalence of a strong wind which may bring about the loss of fine soil particles due to wind erosion. This occurs to an appreciable extent if the land is disc harrowed after the dry ploughing operation. The harrowing is therefore done after a light shower.

At present it is mostly on State Farms and in the Gal Oya Valley that mechanized cultivation of highland crops is carried out to some extent. The tillage operations are mechanized fully and seed drills are used for the sowing of crops. Robot automatic transplanting machines have been used successfully for chilli and tobacco transplanting on State Farms. In the Gal Oya Valley an extent of about two hundred acres was transplanted successfully with chilli, as a trial, in rows three feet apart and a spacing of one and a half feet within the row with two seedlings per hill. These transplanting machines failed to work on soils too sticky or too wet. Row crop cultivation of crops is successfully carried out with integrally mounted spring tine cultivators. Manure spreaders, maize shellers, ridgers and mowers are also being successfully used on State Farms. Combine harvesters, threshing and winnowing machines are being tried

out by the State on a small scale now. Most of the private owners of agricultural tractors at present limit their activities in mechanized farming to tillage operations only, until such time they are advised by the Department of Agriculture whether it is profitable or not to undertake operations such as threshing and harvesting.

It has been observed that the introduction of mechanized tillage operations into areas newly opened up by cutting down jungle land and developed by using human power has resulted in damage to the machinery due to the presence of side roots of tree stumps lying in the ground. This fact lays stress on the necessity to use machinery on jungle land being cleared for agriculture so that an efficient job of land development work could be done before introducing mechanized agriculture to such areas.

Irrigated Paddy Cultivation

Paddy is normally cultivated in irrigable fields and for this purpose the fields consist of checks each varying in size from a few square feet in some areas in the hilly country to two acres or more in certain parts of the Dry Zone. Out of a total extent of about 900,000 acres under paddy, only about 250,000 acres could be regarded as suitable for mechanized cultivation. About half this extent could be tractor ploughed at present with the number of agricultural tractors available in the country, which is about six hundred. New areas are being developed for cultivation in the various colonization schemes sponsored by the State, and the tillage operations in these schemes, where there is a shortage of cattle and labour, will have to be done by tractor. The demand for tractor cultivation is increasing rapidly and it is not possible to cope with this demand with the machines available at present.

Disc ploughing, mouldboard ploughing or double tine tilling is practised as preliminary tillage for paddy cultivation, depending on the type and condition of the soil. Disc plough is used on hard soils and the mouldboard plough is used on loamy soils which have a fair amount of moisture. The tine tiller used twice on light soils free from weeds and sufficiently moist has done a very satisfactory preparatory tillage operation for paddy cultivation. If the soils are too dry and tough for the tractor plough, a light irrigation of the soil solves the problem.

The use of tractors with trailed implements in the checks of paddy lands is very cumbersome, and the introduction of easily manoeuvrable tractors with mounted implements where the tractor and the implement work as one integrated unit, has encouraged the paddy farmer to a certain extent to resort to mechanized methods of agriculture. This type of machine is very popular now. The rotary cultivators attached to the tractor are being tried out on a very small scale now and it is still too early to say whether they are more suitable for work in paddy fields in preference to the plough or the tine tiller.

At present only the preparatory tillage operations in paddy cultivation are mechanized, except on State Farms and certain Colonization Schemes, where the seed is sown broadcast and covered lightly with a light disc harrow or drilled with a seed drill. It is done under dry conditions just prior to the

onset of the monsoonal rains. This results in a great saving of irrigation water. The operations of harvesting, threshing and winnowing of the paddy crop are not yet mechanized as the State is still conducting trials with such machinery. The main benefits to the paddy cultivator as a result of mechanizing the tillage operations have been an increase in the yield per acre, saving of irrigation water as the land is normally ploughed dry, and a saving of time for them to attend to the cultivation of highland crops.

Tractor Units

Most cultivators in Ceylon do not own sufficient land to justify the purchase of a tractor, but they are eager to have the benefits of mechanized cultivation. It is partly to cater for this need that five Tractor Units are being run by the State on lines similar to those of the Machinery Units of the County Agricultural Committees in England and Central Tractor Organization in India. They have been established at Kilinochchi in the North, Karativu in the East, Wirawila in the South, Nikaweratiya in the North-West and Nalanda in the Central Province. These Units are combined with Field Repair Depots and undertake work for private parties and State Farms, except those where special agricultural research work is being done. Economic trials conducted by the State on a large scale through these Units have shown that tractor cultivation is profitable in Ceylon under proper management. The demand for tractor cultivation is very great and in the interests of food production these Units continue to function expanding their activities every season. With the financial and technical assistance of the State, some of the Co-operative Agricultural Production and Sales Societies started Tractor Units of their own last year, and are increasing activities in the field of mechanized agriculture. The State-owned Units undertake work in areas not served by the Co-operative Units and serve as models to maintain the quality and price of work at a satisfactory level, in addition to undertaking trials to find out the performance of different types of tractors under local conditions.

Threshing with Tractors at Hingurakgoda Farm

C. R. KARUNARATNE and H. P. B. ELLEGALA

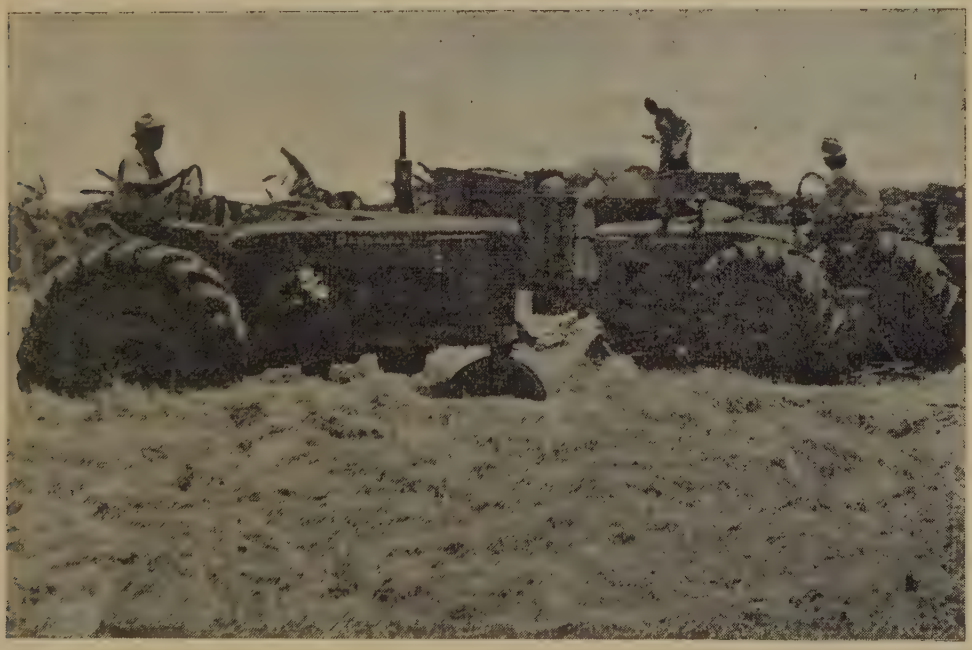
THRESHING and winnowing of paddy have been the most expensive and troublesome of farm operations. The usual, though primitive, systems of threshing paddy are (*a*) beating the earheads against a pole or plank, (*b*) trampling the earheads under the feet of cattle, usually buffaloes, (*c*) and in certain parts of the country, notably in the Batticaloa District, trampling the earheads under the feet of human beings.

These methods of threshing are very slow and laborious. It is not uncommon to see paddy stacks left unthreshed for

long periods for want of buffaloes, owing to these animals being engaged in ploughing and other agricultural operations. Threshing with buffaloes, is as a general rule, done during the night for the convenience of the beasts. This system is by no means satisfactory in major farms or commercial undertakings as it affords room for pilferage.

An attempt was made by the writers to thresh the *Yala* crop of paddy at Hingurakgoda Farm with the aid of rubber-tyred tractors, by working the tractor round with the paddy sheaves spread out over the entire surface of the threshing floor. Owing to the high clearance of rubber-tyred tractors, the weight of the machine and the deep grooving of the rubber tyres, threshing operations by this method have been found to be very economical and expeditious.

The threshed grains were very much cleaner and there was no damage to the grains whatsoever. The straw left after threshing with rubber-tyred tractors was pliant and soft. There is no contamination by cattle urine and dung.



Threshing paddy with tractors at Hingurakgoda Farm

Threshing other farm produce, such as sorghum, cowpea, dhal and green gram, in this way can very economically replace the old-fashioned and laborious method of threshing with buffaloes. The time required for threshing with tractors is approximately one-third of that normally needed for threshing with buffaloes.

With this improved system of threshing, the number of threshing floors on a big farm can be reduced appreciably, as threshing and winnowing operations can be centralised. The sheaves can be transported to these central threshing floors by trailers attached to tractors. It would be decidedly an advantage to

have very spacious threshing floors, preferably cement-rendered, as winnowing operations can then be undertaken with power operated winnowers immediately the threshing is completed (on the same threshing floor and on the same day).

The expenditure incurred in stacking paddy can be dispensed with as the harvested sheaves can be threshed the same day. Comparative statements of costs of tractor-threshing and threshing with buffaloes at Hingurakgoda farm are tabulated below.

(1) Threshing with Buffaloes

Acreage	2 acres
Number of paddy stacks	2
Time taken to complete the threshing	12 hours
	Rs. c.
12 buffaloes at Rs. 2 each	24 0
6 labourers at Rs. 3 per day	18 0
1 watcher at Rs. 4 per day	4 0
Total cost of threshing 2 acres	46 0
Cost of threshing per acre	23 0
Cost per bushel, at 30 bushels per acre	0 77

The threshed paddy is mixed with an appreciable quantity of thrash (*kaatu*) as a result of the breaking up of the straw.

(2) Threshing with Tractors

Acreage		5 acres
Number of paddy stacks		5
Time taken to complete the threshing		4 hours
		Rs. c.
5 labourers at Rs. 3 per day for ½ day		7 50
1 tractor operator at Rs. 5 per day for ½ day		2 50
Supervision at Rs. 5 per day for ½ day		2 50
Fuel consumption of tractor—	*Rs. c.*	
4 gallons kerosine at Rs. 1·25 per gallon ..	5 0	
½ gallon petrol at Rs. 2·50 per gallon ..	1 25	
1 bottle engine oil at Rs. 1·25 per bottle ..	1 25	
Grease, cotton, waste, &c.	1 0	
		8 50
Depreciation on tractor at Re. 1 per hour		4 0
Total cost of threshing 5 acres		25 0
Cost of threshing an acre		5 0
Cost per bushel at 30 bushels per acre		0 17

About 200 acres of paddy were threshed with the tractors at Hingurakgoda farm during *Yala* 1953. From the above it will be seen that threshing with tractors is about one-fifth the cost of that of threshing with buffaloes.

Germination tests carried out by the Agricultural Research Officer, Polonnaruwa, with random samples of farm paddy threshed by tractor are as follows :—

Sample No.	*Germination Per cent.*
1	88
2	95
3	87
4	83

How Farm Mechanisation has Boosted Output in the United Kingdom

A. THOMAS GILLING

THE value of output from farms in Britain in 1939 was £292,000 sterling; in 1953 it was well over £1,000,000,000. This represents a quantity increase in production of over 60 per cent.

This result has been possible only because of intense mechanization on United Kingdom farms—and the process is continuing.

The increased farm output has actually been accomplished without any appreciable increase in the labour force. For instance, in 1939 in England and Wales there were 470,800 male workers regularly employed on farms, and in 1953 the number was 474,700.

Before World War II the acreage in crops and temporary grassland was 9,000,000. Today it is being maintained at about 14,000,000. In other words, about the same number of workers is dealing with about 50 per cent. more farmed land. They are doing it with machines—for without mechanization the task would be impossible.

Not confined to Tractors

In 1939, there were 46,000 tractors in use in England and Wales. Now there are over 350,000. Mechanization, however, has not been confined to the tractor, for engine power has been applied from the dairy to the grain store. But without the vast increase in tractors, the all-round rate of progress would not have been possible.

For instance, with tractors it has been possible to plough and cultivate many more acres of arable land. Because of that further mechanization of harvesting has become necessary. So England and Wales which had about 150 combine harvesters in 1939, and only about 5,000 as recently as 1948, had 16,470 in 1952 and the number will be over 20,000 this year.

With the increase in tractors the number of horses has fallen. There were 846,000 of all classes on farms in 1939. Now there are only 282,000, and the land which used to grow crops to feed the larger number is now largely producing crops for human consumption.

More Tracklayers

Wheeled tractors comprise about 90 per cent. of the total on farms in Britain but where conditions are really heavy the tracklayer has also advanced in numbers. As compared with about 1,700 in 1939, there are now over 17,000.

Horticultural work, market gardens and small-holdings have also become mechanized. In 1944, as an example, there were 11,000 small horticultural tractors (usually of the light two-wheeled hand-guided type) in use; today there are over 40,000.

Tractors, however, are useless without implements to use with them, and the effect on the equipment side of the mechanization of farms in the United Kingdom is well worth study. In 1939, of 420,000 mouldboard ploughs in use, only 12 per cent. were tractor drawn. Now the proportion is about 70 per cent. and is growing each season.

The effect of mechanization on one particular crop—potatoes—can be judged by the fact that in 1946 about 16 per cent. of 180,000 ridging ploughs in Britain were drawn by tractor. By 1950 of 223,000 ridging ploughs in use, 36 per cent. were drawn by tractors and today over 50 per cent. are so drawn.

The disc harrow, particularly in its heavier forms, is almost essentially a tractor implement. There were 9,000 in Britain in 1939, and well over 86,000 now, and there has been an increase of about 150,000 cultivators, almost all tractor operated, in the same period.

Mounted implements are now widely used on U. K.-made tractors. This Ferguson tractor, for example, carries a ridger controlled by a hydraulic pump. The steerage fin mounted behind the central body keeps the ridger in alignment

Mounted Implements

Another revolution that has accompanied the tractor is the use of mounted implements. The pioneer of this development is an Ulsterman, Mr. Harry Ferguson, who started its use over 20 years ago in conjunction with the hydraulic lift. By means of the lift implements can be carried on the tractor itself.

Most pre-war tractors just pulled trailed implements. In other words they merely replaced the draught horse, and the majority of implements were merely adaptations of previously horse-drawn ones. By attaching the implements to the tractor by an hydraulic lift what was formerly a lengthy trailed piece of equipment can be close-coupled to its power-unit.

In addition the system is a great land-saver because it reduces the amount of uncultivated area required at headlands for turning, for an implement so mounted can be used right up to the edge of any field and be lifted and turned in a very small space.

The ability to back a tractor to an implement, couple it up, lift it, and drive straight to the job, too, is of immense advantage.

It is no wonder that this United Kingdom development—used in its early days more in the United Kingdom than anywhere in the world—has been adopted or adapted by practically every manufacturing country.

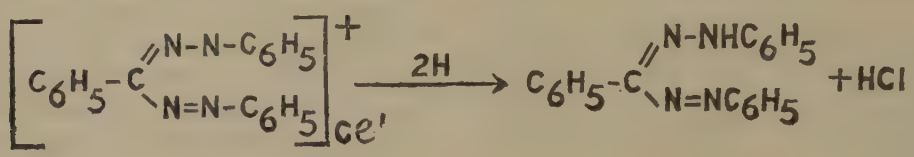
I–The Use of Triphenyl Tetrazolium Bromide in Viability Tests of Rice Seed

J. J. NILES

ESTIMATES of viability by germination tests, apart from taking 6-10 days and requiring elaborate equipment, are possible only with non-dormant seed. A simple and rapid method of determining viability, applicable even to dormant seed, by the use of Triphenyl tetrazolium bromide is described in this paper.

Many chemicals have been tried by various workers as seed germination indicators with varying success. A topographical test of viable tissue in cereals using Sodium biselenite was originated by Lakon (1939). The toxicity of this reagent compelled him to reject it. Kuhn and Jerchel (1941) demonstrated that tetrazolium salts stained germinating seeds, fermenting yeasts, &c. Lakon (1942 *a*) proposed a method using 2, 3,—diphenyl—5—methyl tetrazolium chloride or 2, 3, 5,—triphenyl tetrazolium chloride. This method was based on the fact that on the gradual dying-off of the embryo,

the topographical spread of necrosis could be traced by the failure of dead tissue to stain. It was demonstrated that this compound, which is colourless, was reduced by living cells into stable but non-diffusible red formazan.



Triphenyl tetrazolium chloride (Colourless) Triphenyl formazan (Red)

Cottrell (1948) found it possible to evaluate percentage germination rapidly by the use of tetrazolium salt. Porter, Durrel and Romm (1947) found that staining with 2, 3, 5-triphenyl tetrazolium chloride showed close agreement with the results of germination tests in some crops. Lakon (1949) summarizes his earlier work, leading to the prediction of the germinability of freshly harvested cereal seed by the use of tetrazolium. The work of Venkataratnam (1951) on rice is of special interest because of its relation to the investigations reported in this paper. He found that in rice and millets there was high correlation between the actual germination and the tetrazolium stain, and that the test was fairly reliable for monocotyledonous seeds.

Materials and Methods

"Grodex" a proprietary brand of Triphenyl Tetrazolium Bromide was used in the investigation which forms the subject of this paper. The procedure adopted was similar to that advocated for maize by Lakon (1942 *b*). A detailed examination of the stained embryo was not made, and as such finer distinctions based on the distribution of stain in different parts of the embryo and the scutellum, which would explain descrepancies with actual germination and growth, were not possible in this preliminary investigation. For the purposes of the present work, a seed in which at least the entire plumule and radicle, half the scutellum and the region between the plumule and the radicle stains is considered viable. (Vide Fig. 1*a* and *b*).

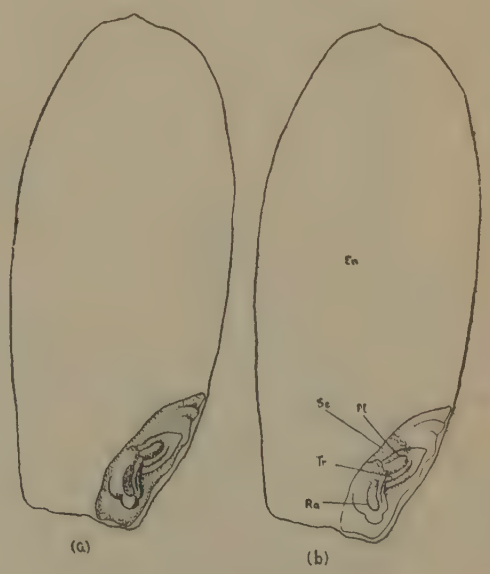


FIG. 1.—Germinable seed is taken to be that in which the stippled area is stained. (Median Longitudinal Section). En=Endosperm, Sc=Scutellum, Pl=Plumule, Ra=Radicle, Tr=Transition region between plumule and radicle.

Triphenyl tetrazolium bromide has not shown any toxic properties. It is water soluble and colourless in solution but forms a red stain on the cut surface of living embryo tissue. Tetrazolium salt solution is light sensitive and so exposure for any considerable time, even to diffused sunlight, was avoided. It was found easier to dissolve the salt in water at 50°C. The seed to be tested were dehusked, soaked in water, and then cut longitudinally, bisecting the embryo medianally. One half of each seed was placed in a Petri dish and the tetrazolium salt in solution was poured over, until the seeds were covered completely. The dishes with the seeds, were then placed in the dark and after a lapse of time a count of stained seeds made.

Primarily it was necessary to determine the optimum method of application. Different periods of pre-soaking the dehusked seeds in water (25°C) were tested. Periods less than 4-6 hours were found insufficient for softening the seed for uniform bisection. A pre-soaking period of 16 hours, commencing at about 4 p.m. was adopted as a most convenient working arrangement. Investigations of the suitable concentrations of the reagent and the staining periods were made.

Investigations of Technique

Seed of the pureline *Sulai* 301, of 3½ months duration, which was in storage for over 1½ months and in which its short dormancy period had fully expired, was used in this experiment. The actual germination percentage of the seed was found to be 98.3. The dehusked seeds were pre-soaked over-night in water (25°C) for 16 hours and the bisected seeds placed in Petri dishes, with the cut surfaces facing upwards.

Treatments —

(1) Concentrations of Tetrazolium solution .. (*a*) = 0·1 per cent.
(*b*) = 0·5 per cent.
(*c*) = 1·0 per cent.

(2) Staining periods .. .. (*a*) = 15 minutes
(*b*) = 30 minutes
(*c*) = 60 minutes
(*d*) = 120 minutes
(*e*) = 240 minutes

There were three replicates of the 15 treatment combinations.

Results—The analysis of variance of data transformed to the inverse sine scale appropriate to a binomial distribution is given in Table 1. Treatment means are summarized at the foot of the Table.

Table 1.—Analysis of Variance of Transformed Data

$$\theta = Sin—1 \sqrt{p})$$

	Degrees of freedom	Sum of Squares	Mean Square	Variance Ratio	F value at 0·1 per cent. point
Treatments	14	47,476·33	3,391·17		
Concentrations	2	4,589·31	2,294·66	126·15***	8·93
Staining periods	4	38,270·54	9,567·64	525·98***	6·25
Interaction	8	4,616·48	577·06	31·72***	4·69
Replicates	2	14·50			
Error	28	509·42	18·19		
Total	44	48,000·25			

*** Significant at 0·1 per cent. point.

Individual Means in Degrees

(Subscript denotes Mean Percentage)

Staining Periods Minutes	Concentrations 0·1%	0·5%	1·0%	Means	Standard Error	Sig. Diff. at 5 per cent.
15	1·9	3·8	10·0	5·2		
	(0·3)	(0·7)	(3·3)			
30	12·6	54·0	68·5	45·0		
	(5·0)	(65·3)	(85·7)			
60	34·9	76·5	81·9	64·4	± 1·42	4·12
	(33·0)	(93·7)	(98·0)			
120	76·2	82·9	82·7	80·6		
	(94·3)	(98·3)	(98·3)			
240	85·4	86·2	85·4	85·7		
	(99·0)	(99·3)	(99·0)			
Means	42·2	60·7	65·7			
Standard error	±	1·10				
Significant difference at 5 per cent.		3·20				

The two main treatments and their interaction attained significance at 0.1 per cent. point. All concentrations and staining periods differed significantly from each other. The regressions of staining percentage on concentration and period were marked.

It is evident from these results that 1.0 per cent. concentration with a staining period of 60 minutes is the most satisfactory, if time is an important consideration. The lowest staining period at which there was close agreement between the percentage stained and the actual germination was at this particular combination. If on the other hand, the chemical is in short supply a 0.1 per cent. concentration for a staining period of 240 minutes could be adopted. The relation of staining percentage to concentration and staining period is plotted 3—dimensionally in Figure 2.

Correlation of Staining with Viability

The main object of this study was the estimation of the correlation between potential germination and the tetrazolium test. In pursuance of this, and in the light of earlier observations, tests were conducted with six varieties of paddies of 3 to 4 months duration for determining the correlation coefficients. Seeds which were placed in solution with the cut surface down developed a stronger stain. Two categories have accordingly been recognized. The dehusked seeds were pre-soaked for 16 hours, bisected longitudinally and then treated with a 0.1 per cent. solution for 240 minutes. The results are given below.

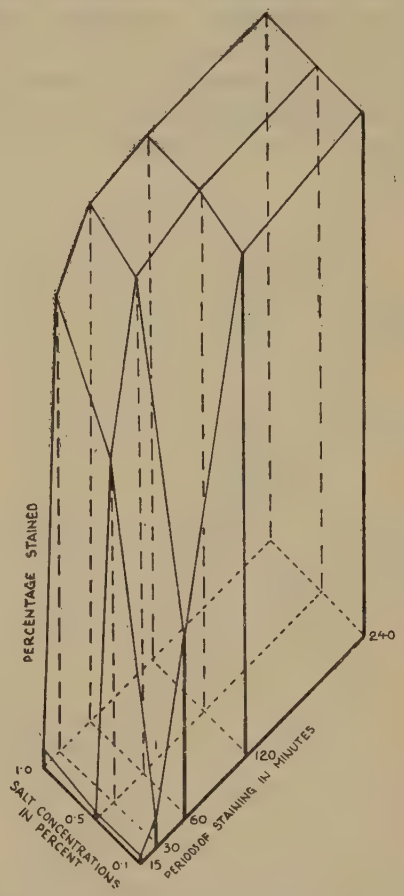


FIG. 2.—Three-dimensional graph showing the distribution of percentage stained in relation to salt concentrations and periods of staining.

Table 2.—Correlation Coefficients between Potential Germination and Tetrazolium Test

Position of Seed	*r*	*S. E.*	*Differences between paired values* —	+	*Sum*
Cut face up ..	.. + 0·994	.. ± 0·003 ..	41 ..	7 ..	—34
Cut face down ..	.. + 0·992	.. ± 0·004 ..	0 ..	66 ..	+66

The coefficients were significant at 0.1 per cent. point and indicate almost complete correlation. In order to ensure that viability is not over-estimated, the placing of seeds with the cut surface up should be preferred. The magnitude of the correlation establishes the fact that germination tests can be replaced by staining tests with tetrazolium salt. The relation of percentage stained by the tetrazolium test (cut surface facing up) to actual germination is plotted in Figure 3.

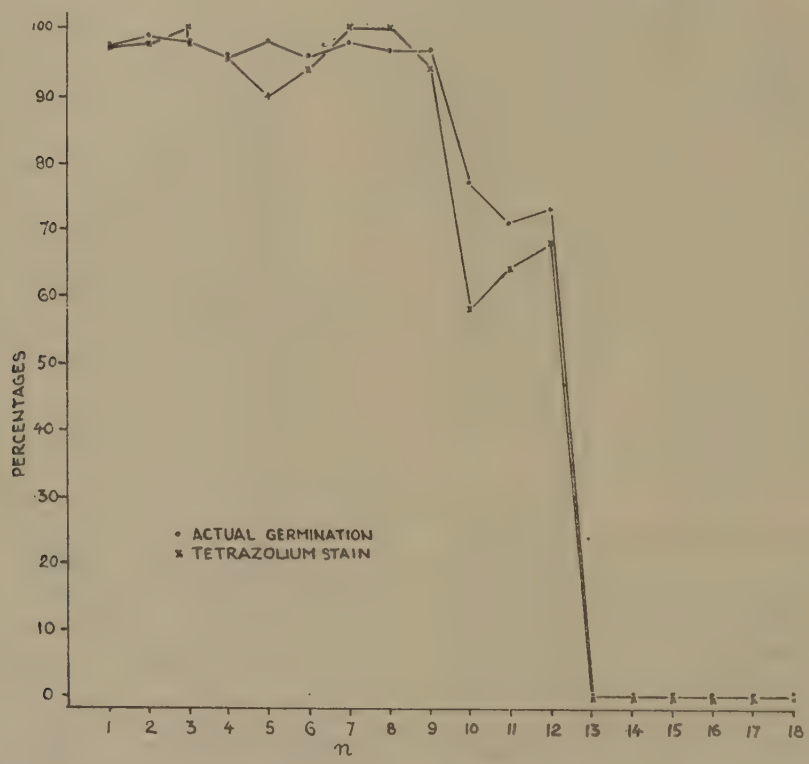


FIG 3.—Relation of percentage stained to actual germination in n paired observations.

Dormancy

One of the chief uses of this staining test with tetrazolium salt is that even in seed which is dormant, the eventual germinability can be predicted with certainty immediately after harvest. This fact is of immense value to the rice grower, particularly when dealing with late photoperiod-sensitive varieties (1952). The period of dormancy often exceeds six weeks, and normally expensive processing and storage become necessary before suitability for use as seed can be determined. By the tetrazolium salt test the eventual germinability can be determined immediately after harvest, and grain unsuitable for seed purposes can be diverted to other uses.

Djalen, a 5½ months variety, relatively insensitive to the photoperiod, and *Panduruwi*, a 6 months variety, which is

highly sensitive, were tested for actual germination by standard laboratory methods at weekly and fortnightly intervals respectively from the date of harvest. Parallel tests with tetrazolium salt were set down four days after the former test commenced, as the peak period for actual germination is on the fourth day. For the tests with tetrazolium salt, the dehusked seeds were presoaked in water for 16 hours and treated with a 0.1 per cent. solution for 240 minutes. The results are given in Table 3.

Table 3.—Corresponding Percentage Figures of Staining and Actual Germination tested at Intervals from Date of Harvest

Djalen (Harvested = 23.11.53)			*Panduruwi* (Harvested = 2.12.53)		
Date Tested	*Mean Percentage*		*Date Tested*	*Mean Percentage*	
	Actual Germination	*Stained*		*Actual Germination*	*Stained*
27.11.53	21·7	100·0	8.12.53	0·0	100·0
4.12.53	46·7	100·0			
11.12.53	83·3	100·0	22.12.53	1·7	100·0
18.12.53	81·7	100·0			
22.12.53	93·3	100·0	5. 1.54	21·7	100·0
31.12.53	100·0	100·0			
8. 1.54	96·7	100·0	19. 1.54	50·0	100·0
14. 1.54	95·0	100·0			
22. 1.54	100·0	100·0			
29. 1.54	100·0	100·0			
3. 2.54	100·0	100·0			

The figures relate to seed that is progressively losing its dormancy but indicates the trend of the complete curve. Complete data relating to senescing seeds up to complete loss of viability are not yet available, but it is expected that the percentage stained will decline *pari passu* with percentage germination.

The effect of the stain on artificially killed seed is of interest in this connection. Seeds of *Sulai* 301, with an actual germination percentage of 98.3 and a corresponding staining percentage of 98.7, were killed by immersion in boiling water for 5 minutes and then tested

with a 0.1 per cent. solution of tetrazolium salt for 240 minutes. The staining percentage dropped to zero in the case of killed seeds.

Discussion

This technique of staining with tetrazolium salt can be widely adopted as a rapid means of determining the viability of rice seed. It should be of particular value to the extension worker who is obliged to purchase dormant seed immediately after the *Maha* harvest. Elaborate equipment is unnecessary. The only precision apparatus that may be out of the reach of some is a sensitive chemical balance. In such cases it should be possible to get the required quantity of the reagent packeted centrally. One gram of the reagent, which costs Re. 1.72, would be sufficient to test a number of samples. The application of the tetrazolium technique to other crops in this country is being investigated. Preliminary tests suggest that the technique may also be of value in testing bull spermatozoa.

Summary

The use of Triphenyl tetrazolium bromide as a germination indicator in rice seed has been studied, and a technique for general use is recommended.

The magnitude of the correlation coefficients establish the fact that germination tests can be replaced by staining tests with tetrazolium salt.

Even in dormant seeds, the eventual germinability can be accurately determined immediately after harvest.

The practical application of the tetrazolium salt test is discussed.

Acknowledgment

I gratefully thank Dr. M. F. Chandraratna and Mr. L. H. Fernando for their valuable help in the preparation of this paper and Mr. Alfred Ratnayake for the illustrations.

References

LAKON, G. 1939— Das Schwinden der Keimfähigkeit der Samen, insbesondere de Getreidefruchte. *Ber. Deutsch. Bot. Ges.* 57 : 191—203.

KUHN, R. and JERCHEL, D. 1941— *D. Ber. Ges.* 74B : 949—952.

LAKON, G. 1942*a*—Topographischer Nachweis der Keimfähigkeit der Getreidefruchte durch Tetrazoliumsalze. *Ber. Deutsch. Bot. Ges.* 60 : 299—305.

COTTRELL, H. J. 1948—Tetrazolium salt as a seed germination indicator. *Annals App. Biol.* 35 : 123—131.

PORTER, R. H., DURREL, M., and ROMM, H. J. 1947—The use of 2, 3, 5 triphenyl tetrazolium chloride as a measure of seed germinability. *Plant Physiol.* 22 : 149—159.

LAKON, G. 1949—The topographical tetrazolium method for determining the germinating capacity of seeds. *Plant Physiol.* 24 : 389—394.

VENKATARATNAM, L. 1951—Seed viability test with 2, 3, 5 tri-phenyl tetrazolium chloride. *Madras Agri. Jour.* 38 : 248—251.

LAKON, G. 1942*b*—Topographischer Nachweis der Keimfahigkeit von Mais durch Tetrazoliumsalze. *Ber. Deutsch. Bot. Ges.* 60 : 434—444.

CHANDRARATNA, M. F., FERNANDO, L. H. and WATTEGEDERA, C., 1952—Seed Dormancy in Rice. *Trop. Agriculturist.* 108 (4) : 261—263.

Evidence of Magnesium Deficiency in Ceylon Soils *

S. KANDIAH and D. M. RODRIGO

INSTANCES of abnormal condition in plants which have been considered by the Pathologist as not being caused by any pathogens are brought to the notice of the Chemist from time to time and these are investigated. When factors such as drought, inadequate soil drainage, &c., are eliminated from being the cause, the possibility of nutritional deficiency is investigated.

A comparison of the diseased leaf specimens with the plates reproduced in "Hunger signs in Crops" or "The mineral deficiency of Plants" did not always give a clue to the trouble. In the instances cited below, though magnesium was found to be the deficient element, the colour symptoms varied with the variety of plants. A comparative analysis of leaves of about the same stage of maturity from the diseased and from healthy plants proved to be far more helpful in diagnosing the cause of the trouble. Where a marked deficiency of any particular nutrient element was observed steps were taken to apply a material rich in that element in sufficient quantity and to watch the effect of the application on the condition of the crop. In the cases referred to below, foliar analysis revealed a deficiency of magnesium and the application of dolomitic lime brought about an improvement in the condition of the plants.

Sickle Leaf of Cocoa

The name "sickle leaf" for the diseased cocoa aptly describes the condition of the leaf, which narrows down to the base with a curvature to one side resembling a sickle. The two halves of the leaf blade are unequal, one being broader than the other. The affected leaves are often chlorotic, the chlorosis being intravenal with the veins remaining green, as opposed to "vein clearing" connected with another disease presumed to be a virus. In advanced cases, defoliation of the twigs takes place and the entire tree presents an unthrifty appearance. The analysis of leaves collected from healthy and diseased trees at the Departmental Station, Kundasale, and from healthy trees at Gannoruwa, where this disease does not occur are given in Table 1.

Table 1

Cocoa	*%Ash*	*% Nitrogen*	*%Phosphoric acid (P_2O_5)*	*%Potash (K_2O)*	*%Lime (CaO)*	*%Magnesium (MgO)*
1. Healthy tree—Kundasale	8·50	2·48	·87	2·05	·98	1·29
2. Diseased tree ,,	9·75	2·11	·42	2·55	1·14	·94
3. Healthy tree ,,	12·81	2·13	·45	1·62	2·38	1·32
4. Diseased tree ,,	9·82	1·99	·51	2·69	1·31	·97
5. Healthy tree ,,	12·97	2·06	·41	1·33	2·24	1·44
6. Diseased tree treated with dolomitic lime—Kundasale	11·18	2·28	·58	1·53	1·67	1·46
7. Healthy tree—Gannoruwa	9·06	2·05	·47	1·96	1·11	1·43

* A paper read at the ninth annual sessions of the Ceylon Association for the Advancement of Science held in November, 1953.

A glance at the results would indicate a generally low level of nutrients in the diseased leaf, but the potash content is much higher and the magnesium content much lower in the diseased leaf when compared with those in the healthy one for these two constituents. It is a significant fact that cocoa cultivated on soils derived from dolomitic lime stone is free from "sickle leaf" and that the two estates, Kundasale and Pallekelle, where this disease is severe do not contain any dolomitic lime stone. It therefore appeared reasonable to infer that a deficiency of magnesium was responsible for the disease at Kundasale and the effect of applying dolomitic lime was tried out. The treated trees show a marked improvement in their general condition, a reduction in chlorosis and in the number of sickle shaped leaves. The increase in magnesium in the plants treated with dolomitic lime would appear to confirm that magnesium was the limiting factor.

Citrus at Helbodde

Practically all the Tahita seedless lime trees planted at the Fruit Station at Helbodde had turned chlorotic in spite of regular dressings of cattle manure, application of coral lime and artificial fertilizers and periodic spraying of zinc sulphate. The affected leaves drop off prematurely and the twigs remain bare giving an unthrifty appearance to the whole plant. The soils are deep and the plants are planted in terraces. There was no evidence of any water logging. As the soils are acid lateritic loams, it was considered possible that available phosphoric acid was the limiting factor but an application of basic slag given at the rate of three pounds per tree failed to bring about any improvement.

Leaf analysis shown in Table 2 was carried out at this stage and it revealed a deficiency of lime and of magnesium. As the chlorotic condition persisted even after the application of coral lime, it was decided to test the effect of dolomitic lime, calcium-magnesium carbonate. A fairly heavy dose of 7 lb. per tree was given on November 23, 1951. After a period of about 6-9 months, some improvement was noticed in every one of the trees, but the response in some cases was more marked than in others. A few of those that did not show much improvement were selected and treated on October 22, 1952, with 4 lb. per tree of magnesium sulphate, to which these trees responded remarkably. A similar dose was thereafter given to the other trees also. At present none of the treated trees shows any symptoms of chlorosis and all of them are in a flourishing condition and have begun to bear fruits after a period of about five years. The improvement in the plant is reflected in the higher content of magnesium in the leaves of the treated plants.

Table 2

Citrus	*%Ash*	*%Nitrogen*	*%Phosphoric acid (P_2O_5)*	*%Potash (K_2O)*	*%Lime (CaO)*	*%Magnesium (MgO)*
1. Healthy tree—Helbodde	10·72	2·06	·44	1·76	2·02	·98
2. Diseased tree—Helbodde	5·20	1·09	·31	1·82	1·13	·55
3. Diseased tree treated—Helbodde	8·83	1·86	·60	1·78	1·94	1·11

Guava at Meerahawatte

The guava plants at Meerahawatte are about 7-8 years old but all of them were affected to varying degrees by what is known as " rosetting ". Here the leaves turn purple, the veins alone remaining green. Analysis of healthy and diseased leaves carried out on March 10, 1951, revealed a generally low plant nutrient status in the diseased leaves compared with that of the healthy ones. A deficiency of magnesium was not unfortunately suspected at this stage and this element had not therefore been determined in the leaves. A heavy application of artificial fertilizers given to the seriously affected trees failed to show any improvement. Further analysis of leaves from healthy and affected trees were carried out on June 23, 1952, and a general deficiency of plant nutrients in the affected leaves was detected. As the application of a fertilizer mixture had failed to bring about any improvement the effect of an application of dolomitic lime was tested on July 7, 1952, by treating the trees at seven pounds per tree. The treated trees showed a remarkable improvement in their condition and the leaves had all turned green. Here again the improvement in the condition of the plants is reflected among other nutrients in the increased magnesium content of the leaf.

Table 3

Guava	*%Ash*	*%Nitrogen*	*%Phosphoric acid (P_2O_5)*	*%Potash (K_2O)*	*%Lime (CaO)*	*%Magnesium (MgO)*
1. Healthy tree—Meerahawatte	—	2·05	·42	·84	1·05	—
2. Diseased tree ,,	—	1·78	·26	·55	·83	—
3. Healthy tree ,,	6·45	2·12	·42	·82	1·01	·93
4. Diseased tree ,,	3·77	1·94	·32	·62	·80	·67
5. Diseased tree treated ,,	6·39	2·10	·44	·80	1·04	·95

Sorghum at Gal Oya

Specimens of affected sorghum plants were received on January 27, 1953. The leaves were normal in size but they were reddish purple in colour, the change in colour starting with the tips and proceeding downwards in streaks along the mid ribs. The two edges of the leaves remained green, but as the affection advanced, the entire leaf turned more and more purplish. A healthy sample from an adjacent area was called for and a comparative analysis carried out. The affected leaf showed a definite deficiency of magnesium, as could be seen from the results in Table 4.

Table 4

Sorghum	*%Ash*	*%Nitrogen*	*%Phosphoric acid (P_2O_5)*	*%Potash (K_2O)*	*%Lime (CaO)*	*%Magnesium (MgO)*
1. Healthy plant—Gal oya	11·78	2·87	·75	·80	·97	·60
2. Diseased plant ,,	15·02	2·66	·79	·84	·98	·33

Although unmistakable evidence of magnesium deficiency has been detected, it has not unfortunately been possible to test the effect of an application of dolomitic lime, as sorghum is cultivated in these areas only once a year. Action has however been taken to apply dolomitic lime to the affected areas this season.

Maize at Vakaneri

Affected maize from Vakaneri near Valachenai showed similar discolouration as the sorghum and comparative analysis of healthy and diseased leaf samples (Table 5) carried out revealed a generally low level of nutrients in the affected leaf. The deficiency of magnesium was however far more marked than of the other elements. Here again for the reasons stated above, it has not been so far possible to test the effect of treating with dolomitic lime.

Table 5

Maize	*%Ash*	*%Nitrogen*	*%Phosphoric acid (P_2O_5)*	*%Potash (K_2O)*	*%Lime (CaO)*	*%Magnesium MgO)*
3. Healthy plant—Vakaneri	14·86	2·65	·75	1·04	·85	·39
4. Diseased plant ,,	8·22	1·28	·65	·84	·67	·13

From the foregoing it will be clear that these soils are deficient in magnesium. It will be observed that all the cases detected so far have been confined to lateritic soils in the wet zone or the sandy soils in the dry zone. It is a well established fact that laterization brings down a marked reduction in bases. Holland[1] states that during weathering of silicates in the tropics, the silica, alkalies and alkaline earths are removed in solutions whilst the alumina and ferric oxide remain behind. Robinson[2] however points out that during the decomposition of fresh diorite as much as 97 per cent. each of calcium and of magnesium is lost while the corresponding loss for potash is 39 per cent. A deficiency of magnesium in the lateritic soils is therefore easily understood. Sandy soils due to their low percentage of the clay complex are deficient in most plant nutrients including magnesium. The statement on page 20 of the Imperial Bureau of Soil Science Technical Communication No. 31 would indicate how very important is the issue of magnesium deficiency in plant nutrition: "Magnesium is one of the most soluble and most weakly absorbed of the common exchangeable cations and actual deficiencies in soil may be much more common than has yet been recognised".

References

[1] Holland-Commonwealth Bureau of Soil Science—*Technical Communication No. 47.*

[2] Robinson, G. W.—Soils: Their Origin, Constitution and Classification.

Grazing Habits of Indigenous Cattle under Coconuts

G. C. M. GOONESEKERA

WHILE any pasture is naturally reduced by grazing there is also a very considerable reduction, due to the damage done by trampling and bedding, and these crushed areas of grass become focal points for soil erosion and obnoxious weed growths, ultimately resulting in the total degradation of such pastures. Therefore the grazing habits of indigenous cattle on pastures under coconuts were studied at the Coconut Research Institute, to ascertain the following :—

1. Whether individual animals each have a fixed and regular pattern of grazing.
2. Whether this pattern if in existence varies with different seasons.
3. Whether the feeding habits of individual animals are similar.

Method

Five adult animals of varying ages were selected at random. The animals were tethered to palms during observation, but were removed from one palm to the other at eight-hour intervals. They had access to a continuous supply of water.

Twelve twenty-four-hour continuous observations were taken, i.e., one observation a month, and the first was made on July 9, 1952, and the last on June 9, 1953. The observation commenced at 6 a.m. on the 9th of each month and concluded at 6 a.m. on the 10th. These dates were strictly adhered to during every month the observation was done. Each animal was watched and timed separately.

Results

By means of an analysis of variance it was found that grazing during the following four sessions was significantly different from each other.

Sessions		*Grazing Time*
(*a*)	6 a.m.—12 noon	.. 2·9 hours (10,451 seconds)
(*b*)	12 noon—6 p.m.	.. 4·6 hours (16,654 seconds)
(*c*)	6 p.m.—12 midnight	.. 1·8 hours (6,360 seconds)
(*d*)	Midnight—6 a.m.	.. 1·0 hours (3,631 seconds)
	Total 24 hours	Total Grazing Time 10·3 hours

Apart from the main effect explained above for which the experiment was chiefly designed, the analysis throws light on more interesting facts.

(i) The seasonal variation (see Table 1) is statistically significant. This means that the amount of grazing differs significantly during different seasons of the year.

(ii) The variance between animals was not significant. This means that the grazing on the whole by different animals did not differ. Further, certain interactions were found to be significant, e.g.,

(*a*) *Blocks X Treatments.* (Animals x Sessions). Different animals behave differently during the four sessions. This means that each animal has not shown this typical grazing pattern (quantitatively).

(*b*) *Treatments X Seasons.* (Sessions x Seasons). This means that the grazing pattern varied significantly during different seasons, e.g., see Table 3 ; taking treatments "C" and "D" for instance, it will be noticed that during December, January & February (contrary to the general pattern) more grazing is done in session "D" than in session "C". But from March onwards the grazing in session "D" becomes less until in September it is negligible, and again in October and November the grazing improves relative to session "C" (see Fig. 1).

(*c*) *Blocks X Seasons.* (Animals x Seasons). This interaction was not statistically significant. This means that different animals have shown similar grazing patterns in any season. The above finding holds good except for a snag. Normally in a comparative study of responses of different treatments, the treatments should be independent. In this experiment as such, the findings hold good, as far as the grazing in one session does not affect the grazing in another. But on careful study of the raw data it is found that certain animals that deviated from the general pattern by grazing more in session "D" than in session "C" did so because they grazed less in "C". If an animal grazed more than usual in a particular session, it was observed that it ate comparatively less in the following session.

Conclusions

The present studies have shown that the grazing habits of indigenous low country cattle kept under the shade of coconut follow the same routine or pattern, i.e., the animals graze mostly during the hours of daylight from 6 a.m. to 6 p.m. though by far the greatest intensity of grazing is during the latter part of the day from noon to 6 p.m. This holds good only where there is no heavy rain or other factors to disturb the animals during their grazing.

Whenever it rains heavily grazing is suspended and the animals take shelter. Thus if there is heavy rain during afternoon sessions the animals eat more during the early evening session.

The animals are also encouraged to eat a little more during the dawn session, i.e., from midnight to 6 a.m. in the months when there is heavy dew, e.g., in December, January and February, (See Fig. 1.) when the dew makes the coarse and mature grass softer.

In general therefore, the animals should be allowed to graze in daylight only. And should be taken off the pastures at night. Whenever there is heavy rain during the day they may be left out during the night.

In Fig. 1. the graph for September shows that grazing in the dawn session is negligible, owing to the fact that the rains in late July brought forth very good pastures in early September, hence there was heavy grazing during the morning and afternoon sessions.

Acknowledgments

The writer expresses his thanks to Dr. P. Mahadevan, Research Officer (Livestock), Department of Agriculture, who suggested this study and recommended the procedure followed during the course of the experiment and to V. Abeyawardena, Computer, for the analysis of the figures.

References

1. W. J. A. Payne Laing, and E. I. Raivoka. "Grazing behaviour of dairy cattle in the tropics" (*Nature* 1951, Vol. 167 page 610).
2. D. E. Tribe, "Some seasonal observations on the grazing habits of sheep". (*The Empire Journal of Experimental Agriculture*, 1949, Vol. XVII, pages 105-115).
3. D. B. Johnstone-Wallace and Keith Kennedy. "Grazing management practices and their relationships to the behaviour and grazing habits of cattle". (*Journal of Agricultural Science*, 1944, Vol. XXXIV, pages 190-197).

Table 1.—Analysis of Variance

Source	*D. F.*	*S. S.*	*Variance*	*F*	*Significant Level*
1. Animals (Blocks)	4	11,273	2,818	1·736	2·37
2. Seasons (Months)	11	78,971	7,179	4·423*	1·80
3. Treatments (Times)	3	1,603,076	534,359	329·20*	2·60
Interactions					
1. Blocks × Treatments	12	43,812	3,651	2·25*	1·75
2. Blocks × Seasons	44	67,646	1,537	1·	—
3. Treatements × Seasons	33	208,094	6,306	3·885*	1·00
Error	133	215,876	1,623		
Total	240	2,228,748			

Comparison of Treatments

S. E. = 624.
Significant Difference = 883.

Totals :	
6 a.m.–12 noon	10,451
12 noon–6 p.m.	16,654
6 p.m.–midnight	6,360
Midnight–6 a.m.	3,631

The best times for grazing were in the following order :—

(1) 12 noon–6 p.m.
(2) 6 a.m.–12 noon
(3) 6 p.m.–12 midnight
(4) Midnight–6 a.m.

The differences between each session were highly significant.

Table 2.—Animals (Blocks) × Periods (Treatments)

Cow No.	*A*	*B*	*C*	*D*	*Total*
1	2,286	3,370	1,326	541	7,523
2	1,846	3,091	1,330	589	6,856
3	1,940	3,566	1,471	829	7,806
5	1,902	3,327	1,276	776	7,281
16	2,477	3,300	957	896	7,630
Total	10,451	16,654	6,360	3,631	37,096
	28·2	44·9	17·1	9·8	

Table 3.—Treatments × Seasons

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*Total*
A	614	712	823	942	947	1,047	914	713	1,087	863	933	856	10,451
B	1,288	1,129	1,088	1,422	1,442	1,363	1,559	1,336	1,549	1,756	1,279	1,443	16,654
C	353	280	559	408	564	547	609	717	883	415	413	612	6,360
D	355	420	410	301	100	192	171	163	8	409	241	861	3,631
Total	2,610	2,541	2,880	3,073	3,053	3,149	3,253	2,929	3,527	3,443	2,866	3,772	37,096

Table 4.—Blocks × Seasons (Months)

Cow No.	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*Total*
1	538	557	501	687	582	600	738	623	708	570	512	907	7,523
2	456	501	555	474	618	553	600	517	657	707	573	646	6,856
3	536	533	656	612	623	684	598	645	696	781	709	933	7,806
5	535	517	613	621	682	577	659	542	599	731	499	706	7,281
16	545	433	555	679	548	735	658	602	867	854	574	580	7,630
Total	2,610	2,541	2,880	3,073	3,053	3,149	3,253	2,929	3,527	3,443	2,866	3,772	37,096

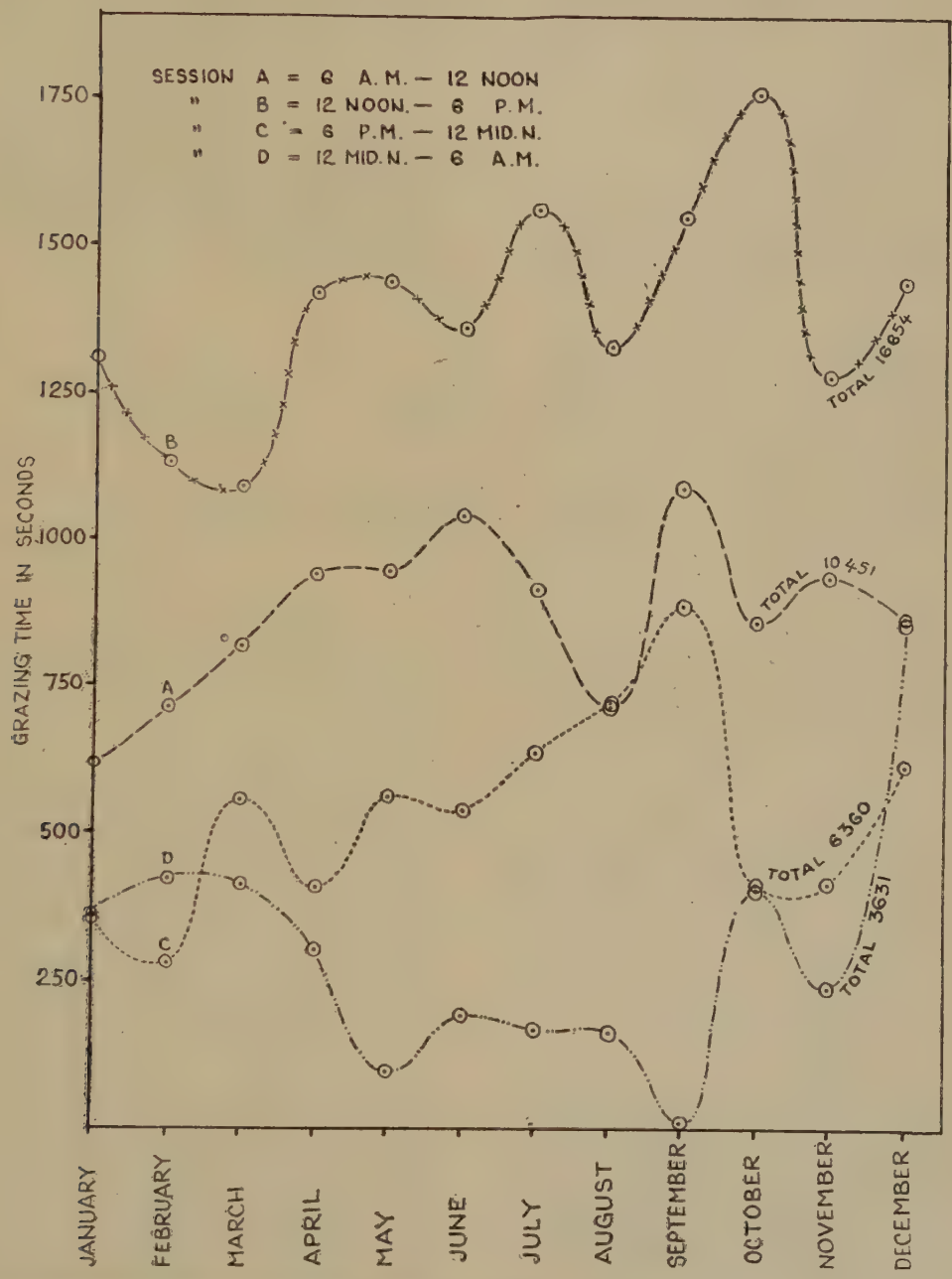


FIG. 1.—A comparative study of the grazing pattern in each session for the year July, 1952, to June, 1953.

Ceylon's Cigarette Tobacco Industry

A. B. ATYGALLE

Cigarette-Tobacco Centres

THE cultivation of cigarette tobacco in the Island has been increased from a meagre extent of 50 acres in 1946 to about 4,500 acres by the end of 1953 with the co-operation of the local cigarette manufacturing companies.

The chief cigarette-tobacco growing centres are:—

Wariyapola	250 acres	in North-Western Province
Katupotha	300 acres	
Ganewatte	1,000 acres	
Melsiripura	200 acres	
Beligamuwa	100 acres	
Galewela	150 acres	Matale North in Central Province
Kudawewa	175 acres	
Wahacotte	100 acres	
Teldeniya	80 acres	Kandy District in Central Province
Mailapitiya	180 acres	
Hanguranketa, Walapane	2,000 acres	Nuwara Eliya District in Central Province

Cultivation Schemes

The cultivation of cigarette tobacco at the above centres was carried out in the following manner:—

(1) Under the green leaf purchase scheme.

(2) Under the cured leaf purchase scheme.

Under the green leaf purchase scheme the companies advance the seedlings and fertilizers to growers and buy their green leaf at agreed prices. The cost of seedlings and fertilizers is recovered when payment is made for green leaf. The companies cure the green leaf in their own barns provided at different centres. This scheme has become very popular among cultivators as it only necessitates careful cultivation of the crop. The Ceylon Tobacco Company at a conference with the Director of Agriculture gave an assurance that they would encourage cultivators to grow tobacco under this scheme to an extent of 2,000 acres. Messrs. Aberdeen Cigarette and Tobacco Co. has just been established. They have started a similar scheme at Ganewatte with an extent of about 100 acres. They state that they are prepared to start similar schemes in other suitable areas as well. The Department of Agriculture and the manufacturing companies give the necessary advice to cultivators on the best methods of growing the crop.

In regard to cured leaf purchase schemes all the companies are prepared to buy whatever quantity of tobacco is produced at agreed rates provided tobacco is grown in areas found to be suitable for the crop and the quality is up to standard requirements. Besides assisting small growers through green leaf purchase schemes the companies are also agreeable to assisting middle class cultivators or co-operative tobacco growers' societies by advancing the following materials for the construction of flue-curing barns:—furnaces, flue-pipes and roofing material. The recovery of the cost of these materials will be made over 5-8 seasons.

Market Prices

The prevailing prices for green leaf and cured tobacco are—

		Rs. c.
Green leaf	Grade 1	0 20 per lb.
Do.	Grade 2	0 8 per lb.
Flue-cured leaf	Grade 1	3 50 per lb.
Do.	Grade 2	3 0 per lb.
Do.	Grade 3	2 75 per lb.
Do.	Grade 4	1 50 per lb.
Do.	Grade 5	1 25 per lb.
	Scrap	1 0 per lb.

It was estimated at various conferences with the manufacturing companies that an acreage from 10,000 to 12,000 acres are required to produce the entire requirements of flue-cured leaf for the local manufacture of cigarettes. To reach this target the development of this industry was forged ahead with assistance of the manufacturing companies during the past years, and it has been possible for the Tobacco Division with its small staff to bring under cultivation a very appreciable extent of 4,500 acres.

Control of Poor Quality Leaf Production

As cigarette tobacco is about the best money crop for Dry Zone areas, growers have resorted to the cultivation of two crops of tobacco during the year in certain areas. This has resulted in the production of tobacco of poor quality. With the introduction of the excise duty on Ceylon leaf and the Indo-Ceylon Trade Agreement the companies have converted their green leaf purchase schemes into cured leaf schemes. Most of the barns belonging to companies have passed on to middlemen who in turn encourage the indiscriminate cultivation of tobacco practically throughout the year, thus leading to the production of poor quality leaf. As there is a ready sale for green leaf the indiscriminate cultivation of tobacco cannot be controlled by advisory work only. In order to prevent this haphazard cultivation and to ensure the quality of local cigarette leaf the Tobacco Committee appointed by the Minister of Agriculture on October 16, 1951 (vide Sessional Paper XVII of 1952) recommended that the cultivation, marketing and manufacture of cigarette tobacco be controlled by an Act of Parliament.

Owing to certain factors connected with import and excise policy there is a falling off in the demand for cigarettes manufactured from Ceylon grown leaf. Expansion of cigarette tobacco cultivation may accordingly be slowed down.

Cigarette Tobacco in Jaffna Peninsula

With the object of replacing the chewing and the strong cheroot tobaccos grown in Jaffna Peninsula, cigarette-tobacco trials were initiated in 1950 at the following important tobacco-growing centres:—Neervely, Tellipalai, Uduvil, Vembirai. The results of these trials conducted during the past years indicated generally that the burning quality of leaf was poor, except the samples from the Neervely centre. On account of the poor burning quality of leaf in Jaffna Peninsula the manufacturing companies cautioned the Department to continue the trials on restricted extents.

At the four centres in Jaffna Peninsula the following extents are being grown under a scheme of assistance from the Ceylon Tobacco Co. and the Department of Agriculture:—

Neervely	..	30 acres
Tellipalai	..	16 acres
Uduvil	..	5 acres
Vembirai	..	12 acres

Assistance to cultivators in the above areas is given through Co-operative organisations.

Seed Production of Cigarette Tobacco

W. M. WIJERATNE

THERE has been in recent years an increasing interest in the cultivation of cigarette tobacco and at present the growing of this crop has come to be recognised as a highly remunerative venture in the agricultural economy of the Island.

One of the major factors that will help to establish and foster this industry is the availability of seed that will not only give a satisfactory percentage of germination but also produce an abundance of strong healthy plants capable of yielding a desirable number of leaves typical of the variety in size and quality. Thus, in the selection of plants for seed the main object is the achievement of high yields of quality leaf.

Qualities of Cigarette Tobacco Leaf

In cigarette tobacco quality is an element which is governed by three attributes:—1. physical chracters of the leaf, 2. chemical composition, and 3. burning qualities.

As regards the physical characters, the most important are the texture, body and colour. An open-textured thin leaf with bright colour is considered to be the best. Among the chemical constituents, nitrogen, total and volatile nicotine, starch, sugars, ash, potash and chlorine contents determine the quality of leaf, which should be rich in carbohydrates and low in albuminoids. A high percentage of potash and low content of chloride in the ash go to produce leaf of good burning quality. A large amount of chlorine in the tobacco reduces the fire-holding capacity, but this ill effect is to a certain extent counteracted by the presence of a high content of potash in the leaf. Likewise, lime and potash are essentials for promoting combustion. The physiological strength of the leaf is gauged by the percentage of nicotine. The strength or volume of aroma is indicated by the amount of gum on the cured leaf.

Burning qualities cover several elements of combustibility, including fire-holding capacity, the rate, evenness, and completeness of burn and the character of the residual ash. A good fire-holding capacity with a relatively slow burn ending in a white compact ash following a complete combustion may be expected from smoking tobacco of good burning qualities.

Although the factor of quality is analysed briefly above, there are two important difficulties in its realization; (1) the elements of quality in tobacco are not easily measurable on the plants selected for seed; (2) they are enormously influenced by soil and environment. Soil, fertilizers, cultural methods, methods of harvesting and curing have all an important significance in determining quality. Though quality may not be definitely linked to genetic factors, some characters are considered to be associated with traits as flavour and aroma. Of the many characters available, tissue structure, elasticity, combustibility and character of ash give a better clue.

Selection of Plants for Seed

In the matter of seed selection as a means of multiplying for the needs of the average farmer, it is essential to have a variety which has been proved to be consistent in producing high yields of quality leaf. Based on such material the efforts of growers in seed selection are directed to such features as size, shape, thickness, number, spacing, venation and colour of leaves, earliness of maturity, suckering habit and disease resistance of the plant.

In the selection of plants for seed purposes it is advisable to go through the crop when it is about 1½ months old and mark off a much larger number than is actually required, so that a final selection could be made later from these plants at a subsequent period of growth. The primary consideration in the selecting of a plant for seed is its conformity to a standard typical of the variety, with a vigorous and uniform growth, with similarly coloured leaves of desirable texture with fine veins and small mid-ribs. The main veins on each side of the lamina should be 8, 9, or 10 in number. They should be thin and not fibrous nor prominent. The angle they form with the mid-rib should be wide. They should curve upwards towards the apex near the margin. The secondary veins should be fine and plants showing distortions resulting

primarily from these veins should be rejected. The leaf should be silky in texture with no crinkling or in-rolling at the margins. It should possess body and gum with slight leaf hairs on the upper epidermis.

A typical Harrison's Special leaf is ovate in shape with a slightly accuminate wide spread apex. The base of the leaf adjacent to the axil should be small for obtaining clean strips. The size of the "cutter" or middle leaf should approximate 26″-30″ in length and 12″-18″ in width. The plant should be 5-5½ feet high with a strong, sturdy stalk. A minium of 15-18 good leaves suitable for flue-curing should be available on a selected plant. The leaf should be placed on the stalk at an angle of 60-70 degrees. The speed of ripening should also be given due consideration in selecting plants. Plants with early ripening leaves should be selected in preference to those that are late maturing.

After having made the preliminary selection on the basis of the above characteristics, it is necessary to watch for the flower heads to appear before a final selection is made. With the appearance of the flower heads, and before the blossoms have opened these selected plants should again be carefuly examined and only those showing the greatest uniformity in development, while still retaining the desirable characteristics, should be marked out for selection of seed.

Bagging Flowers for Seed

After the second selection, one or two flowers should be allowed to open out on the flower heads. These open flowers should be removed with a sharp pen knife or scissors together with all flowering branches except the three or four at the top. At the same time the top leaves should be removed to the level at which the plant would otherwise be topped.

In the selection of tobacco seed it is essential to aim at self-fertilization of the flowers to ensure a progeny true to the type of the plant selected. Hence the flowerhead thus prepared should be covered by inverting a large brown paper bag and tying it closely round the stem of the plant to avoid the possibility of cross-fertilization. The flower heads should be given a light dusting with D. D. T. powder before "bagging". If not for the high cost, muslin bags will be more suitable for this purpose especially in areas where strong wind and rain are experienced. In covering the flower head with a brown paper or muslin bag, it is essential to leave sufficient space for the further growth of the flower head.

In most tobacco-growing areas of Ceylon it has been experienced that strong winds have a tendency to bring down "bagged" plants due to their top-heavy nature unless sufficient support has been given to them. Thus, it is important that a stake of the height of the tobacco plant should be driven firmly at the side and the covering bag tied to the flower head and stake to withstand the ravages of strong wind.

The paper or muslin bag should be removed once a week to inspect the developing flower head. If any insects or larvae are noticed on these occasions it is advisable to give a further light dusting with D. D. T. powder before the bag is replaced. After about 70 capsules have been formed the remaining

unopened flowers and secondary shoots should be removed, as the whole strength from the plant needs to be conserved for the fullest development of the seed already formed.

Final Selection and Harvesting

At this stage it is important to make the final observations on the manner in which the leaf ripens on the selected seed plants. Retaining only those plants with leaves showing an even degree of maturity, the others are topped and the seed heads destroyed. Leaf from the finally-selected plants should not be harvested for curing as the seed heads will need all the food stored in them for complete development.

When the capsules left on the finally-selected plants have all turned brown, the seed heads with a piece of the stem should be cut from the plant and stored in a cool dry place with the paper bag still attached and with the capsules upwards until they are fully dry.

In the process of drying the seed, it will be observed that a certain population of empty and light seed are obtained. As with other crops the heavier the seed the more vigorous and sturdy are the plants to be expected. Hence a careful winnowing or a separation with a seed grader should be done to obtain the best seed.

Storage and Sterilization of Seed

Tobacco seed stored under proper conditions will retain its vitality for a couple of years. Under unsuitable conditions, however, loss of viability will occur within an year. Blue or amber tinted glass bottles have been found to be very suitable for storing tobacco seed. The bottles of seed shoould be well corked and stored in a cool dry atmosphere for satisfactory germination.

In the control of disease the first essential requirement is the use of disease-free seed. Hence, it is advisable to adopt a simple treatment of seed that would take little time but would be a valuable protection against disease.

There are two easy methods of sterilization of tobacco seed that may be adopted :—

(1) Prepare a solution of corrosive sublimate (bichloride of mercury of the concentration of 1 part in 1,000 parts of water. Place the seed in the solution and keep it well stirred for 5 minutes ; allow seed to settle, pour off the liquid, and then spread the seed and dry in the shade.

(2) Dissolve 9 grains of silver nitrate in a pint of water. Place the seed in this solution and keep it stirred for 15 minutes—then drain off the solution and wash the seed in six changes of fresh water ; spread and dry in the shade.

Although the above recommendations have been suggested as a precaution against the occurrence of disease in the field, there is little evidence generally that tobacco seed treatment is always necessary unless it has been found that the field from which seed was selected had suffered from virulent diseases such as wild fire and black fire. In practice if a thorough selection has been done in the field, there is little necessity for sterilizing seed before sowing.

A Note on the Characters and Performance of Some Sweet Potato Varieties

K. J. GUNEWARDENA

SWEET POTATO—*Ipomoea batatas*—a native of South America was introduced into Ceylon many years ago and is now extensively grown in village gardens.

This paper describes the performance of ten varieties at the Experiment Station, Peradeniya.

Morphological Characters of the Varieties

A. Vines pigmented or distinct pigmentation at nodes and axils.

Vines—Slender, hairy and purple.

Leaves—Purple petioles and tender leaves dark purple, cordate to trilobed, upper surface of older leaves green, lower surface light purple with tinted veins.

Tubers—Round, white epidermis, deep yellow flesh.

SUMAR BIG YELLOW . . . . . (1)

B. Tender leaves green, veins purple.

Vines—Slender and short internodes.

Leaves—Long petiole, both ends purple pigmented with streaks of purple on the lower side, palmately 3-5 lobed, purple veins on the lower side.

Tubers—Conical and warty at base, light red epidermis, light cream flesh.

B—5 . . . . (2)

Vines—Long and green, axils of leaves purple.

Leaves—Petiole long, both ends purple pigmented, cordate to trilobed, veins purple on the lower surface.

Tubers—White epidermis, white flesh.

WHITE MALTESE . . . . (3)

Vines—Long and green, nodes and axils of leaves purple.

Leaves—Petiole, both ends purple, trilobed, veins on the lower side of leaves purple.

Tubers—Large and long, white epidermis, white flesh.

V—52 . . . . (4)

BB—Tender leaves purple, veins green.

Vines—Short and green, prominently hairy, short internodes.

Leaves—Short petioles, tender leaves purple, cordate to trilobed, veins green

Tubers—Medium sized, bright yellow epidermis, golden yellow flesh.

GOLDEN YELLOW . . . . (5)

Vines—Short and green, hairy.

Leaves—Petioles short, tender leaves, purple cordate to trilobed, veins green.

Tubers—Long, light yellow epidermis, light yellow flesh.

YELLOW . . . . (6)

AA Vines green and without pigmentation at nodes and axils.

Vines—Short and stout.

Leaves—Tender leaves purplish at the margin, palmately 5-9 lobed.

Tubers—Long, cylindrical, red epidermis, light cream flesh.

GANDIA . . . . (7)

Vines—Long vines, prominently hairy.

Leaves—Laminal end of petiole purple, leaves 4-7 lobed.

Tubers—Large and cylindrical, red epidermis, white flesh.

Murisee . . . . (8)

Vines—Stout and prominently hairy.

Leaves—Laminal end of petiole purple, palmately mostly 5-lobed, margin of leaves purplish.

Tubers—Long, red epidermis, white flesh.

GONA MURISEE . . . . (9)

Vines—Long and slender, hairy.

Leaves—Hairy, mostly cordate, margin of leaves light purple.

Tubers—Round, white epidermis, light yellow flesh.

WANNOP . . . . (10)

Experimental Results

THE above varieties were tried out in a randomized block design of three replicates. Each plot measured 12 ft. by 12 ft. All plots were separated by shallow drains 2 ft. wide and 10 ins. deep to facilitate weeding. Cuttings about 12 ins. long were planted 10 ins. apart on flat beds. A month after planting, the plots were weeded, and a dressing of sulphate of ammonia at 300 lbs. per acre was given. A border of 2 ft. round each plot was discarded at harvest keeping a nett area of 100 sq. ft. The yields of the varieties were as given below.

Weights of Tubers

Blocks	*Golden Yellow*	*Sumar Big Yellow*	*Yellow*	*Wannop*	*Gandia*	*White Maltese*	*Gona Murisee*	*B.5*	*V.52*	*Murisee*
I	27	25	23	20	14	12	29	25	19	13
II	13	22	31	21	12	18	22	31	09	14
III	18	22	35	12	26	09	19	40	08	25
Total	58	69	89	53	52	39	70	96	36	52
Means	19·30	23·00	29·66	17·66	17·33	13·00	23·33	32·00	12·00	17·33

Analysis of Variance

	D. F.	*S. S.*	*M. S.*	*F.*	*5 per cent. point*
Blocks	2	22·87	11·43	—	—
Varieties	9	1,165·47	129·49	3·46	2·46
Error	18	673·13	37·39	—	—

Standard error of the mean of each variety $= \frac{6 \cdot 11}{\sqrt{3}} = + 3 \cdot 51.$

Significant difference 5% level $4 \cdot 98 \times 2 \cdot 10 = 10 \cdot 45$

1% level $4 \cdot 98 \times 2 \cdot 88 = 14 \cdot 34$

Summary

THE results indicate the superiority of *B—5* to *V.—52*, *Wannop, Gandia, White Maltese* and *Murisee* at the 1 per cent. level of significance. B.5 is also superior to golden yellow at the 5 per cent. level of significance. There are no significant differences between the varieties *Yellow, Sumar Big Yellow, Gona Murisee,* and *B—5.*

Flour and Food Preparations from Sorghum, Maize and Kurakkan

C. CHARAVANAPAVAN

SORGHUM maize and kurakkan can be grown in areas unsuitable for paddy. These grains are quite useful as substitutes for rice. Many palatable foods can be prepared from them.

Sorghum Rice Substitute

There are a number of varieties of sorghum which are suitable for human consumption. These varieties have a comparatively thin seed coat and are free from bitter taste. Sorghum is usually contaminated with sand. The sand can be removed by sifting the grains under water in an earthen vessel with a rough inside surface. The moist grains are pounded lightly in a wooden motar and the husk is winnowed off. This is repeated twice or

thrice until the grains are comparatively free from husk. A little water may be sprinkled to moisten the grains while pounding, to facilitate the removal of the husk. The grains are then dried thoroughly in the sun and stored in dry airtight containers.

Sorghum Flour

Dehusked sorghum is soaked in water for about 6 hours, the water is drained off and the grains are pounded into flour. The flour is sifted to the required degree of fineness, roasted gently in a hot open pan to expel moisture and stored in dry airtight containers. Sorghum rice substitute can also be ground into flour in a cereal grinding mill.

Maize Rice Substitute

The grains are soaked in water for 4 hours and the water is discarded. The wet grains are pounded in a wooden mortar and the husk is winnowed off. This is repeated three or four times until the grains are comparatively free from husk. A little water may be sprinkled to moisten the grains while pounding, to facilitate the removal of the husk. The husked grains are pounded and broken up into small particles similar to rice. The product is dried thoroughly in the sun and stored in dry airtight containers.

Maize Flour

Maize flour is prepared from maize rice substitute in the same manner as sorghum flour.

Kurakkan Flour

Kurakkan is best used in the form of flour. Kurakkan is invariably contaminated with sand. The sand is removed in the same manner as described under sorghum rice substitute, after the thin seed-coat is removed by pounding and winnowing. To eliminate the coarseness in ordinary kurakkan flour preparations, the grains are parboiled in water for about 15 minutes until they begin to burst. The water is discarded, the grains are dried thoroughly in the sun and ground into flour in a hand operated stone mill or a cereal grinding mill. The flour is stored in dry airtight containers. Kurakkan flour processed in this manner should give soft and palatable food preparations.

Boiled Rice Substitute from Sorghum and Maize

One cut-measure or sorghum rice substitute is boiled with three measures of water and salt to taste, until well cooked and excess water evaporates. One cut measure of maize rice substitute requires four measures of water. It is cooked in the same manner as Sorghum.

Milk-rice Substitute from Sorghum and Maize

Boiled rice substitute prepared from one cut-measure of sorghum or maize is treated with the milk of one medium size coconut and cooked until excess water evaporates. The milk-rice substitute is spread on a plate, allowed to cool and cut into suitable pieces.

Porridge from Sorghum and Maize

One cut-measure of the small bits of rice substitute from sorghum or maize is boiled with four measures of water and salt to taste until the product is well cooked. The milk of half a medium-sized coconut or one pint of cow milk may be added just before removing from the fire.

Rotti from Sorghum, Maize and Kurakkan

One cut-measure of sorghum or maize or kurakkan flour is mixed with the scrapings of one medium-sized coconut and salt water to taste. The mixture is kneaded with sufficient clean water to form a soft dough. The dough is turned into small balls and flattened out to form the rotti. The rotti is baked on a hot iron plate and turned over to bake the other side.

Pittoo from Sorghum, Maize and Kurakkan

One cut-measure of sorghum or maize or kurakkan flour is roasted gently in a hot open pan until it becomes quite crisp. This is mixed with the scrapings of one medium-size coconut and salt water to taste. Sufficient clean water is sprinkled and the mixture is stirred to form small granules. The product is steamed till well cooked in a "pittoo bambu" placed over a pot of boiling water, or in a conical shaped perforated basket placed over a pot of boiling water and covered with another pot.

Stringhoppers from Sorghum, Maize and Kurakkan

One cut-measure of sorghum, maize or kurakkan flour is steamed till well cooked in a conical shaped perforated basket, placed over a pot of boiling water and covered with another pot. The steamed flour is broken up and sifted through a sieve. If steaming is not possible, the flour can be roasted gently in a hot open pan until it becomes quite crisp and then sifted.

The flour is mixed with sufficient boiling water and salt water to taste, to form a soft dough. The dough is turned into balls and squeezed through a stringhopper mould on to small circular cane mats. The mats are placed over a pot of boiling water one on top of the other with cane rings to separate the mats. The pot is covered with another pot and the stringhoppers are steamed till well cooked.

Hoppers from Sorghum

One cut-measure of sorghum flour is mixed with the water of one medium-sized coconut and salt water to taste. Sufficient clean water is added to form a thick batter. A tablespoonful of fermented toddy or yeast from a bakery is mixed with the batter and kept overnight in a covered pot. The leavened batter is mixed with the milk of one medium-sized coconut to form a thin batter. If toddy or yeast is not available, the thick batter is kept overnight as before and treated with one cut-teaspoonful of baking soda before mixing with the coconut milk. A small coconut spoonful of the batter is poured into a hot deep iron pan or chatty smeared

with gingelly oil. The pan or chatty is immediately removed from the fire and given a circular movement to spread the batter evenly.

The vessel is placed on the fire and covered with another deep vessel containing hot embers. The hopper is removed by means of a flat iron spoon when well baked.

Thosai from Sorghum and Maize

Quarter measure of black-gram is soaked in water for 6 hours and the skins are rubbed off and washed away with water. The cleaned black-gram is ground into a paste and mixed with one cut-measure of sorghum or maize flour. To this is added the water of one medium-sized coconut and salt water to taste. Sufficient clean water is added to form a thick batter. A tablespoonful of fermented toddy or yeast from a bakery or curd is mixed with the batter and kept overnight in a covered pot. The leavened batter is mixed with the milk of one medium-sized coconut to form a thin batter. To this is added a small quantity of fried onions, chillies, curry leaves and mustard and a pinch of turmeric to give a light yellow colour. A small coconut-spoonful of the batter is poured on a flat hot iron plate smeared with gingelly oil. The batter is spread evenly using the bottom of the coconut-spoon. The thosai is turned over with a flat iron spoon to bake the other side.

Halape from Sorghum and Kurakkan

One cut-measure of sorghum or kurakkan flour is roasted gently in a hot open pan until it becomes quite crisp. To this is added half a pound of scraped jaggery, half a pound of scraped coconut and salt water to taste. Sufficient boiling water is mixed to form a stiff dough. The dough is turned into small balls and flattened out on *kenda* leaves or plantain leaves previously withered by heating over a fire. The leaves are folded with the dough inside and placed on a piece of cloth tied to the mouth of a pot of boiling water. The pot is closed with another pot and the halapes are steamed till well cooked.

Thalapa from Sorghum and Kurakkan

One cut measure of sorghum or kurakkan flour is roasted gently in a hot open pan until it becomes quite crisp. One measure of water is boiled in a vessel and the flour is added in small quantities at a time and well mixed with a wooden spoon to form a paste. Salt water is added to taste. The paste is well stirred over a slow fire until it is cooked. The paste is then spread on a plate, allowed to cool and cut into small pieces. Thalapa is usually eaten with gravy. It can also be eaten with sugar, jaggery or treacle, mixed with coconut milk or cow milk.

Kesari-aluwa from Sorghum and Maize

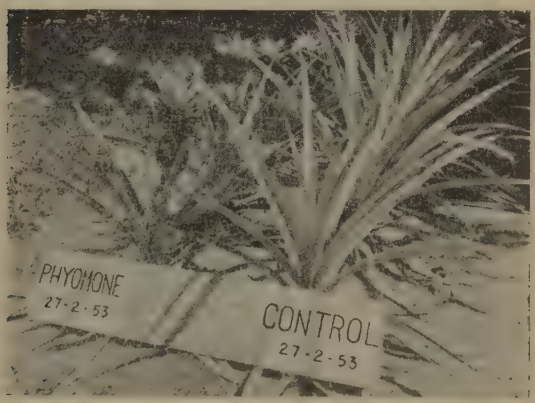
One cut measure of sorghum or maize flour is roasted gently in a hot open pan with four ounces of ghee until it becomes quite crisp. Half a measure of hot water or cow milk is added with half a pound of sugar and salt water to taste. The product is stirred over a slow fire until it is cooked. It is then spread on a plate, allowed to cool and cut into small pieces.

Research Notes

Flower Induction in Pineapple

PINEAPPLE plants grown from suckers which are planted at the same time in the field do not always flower uniformly, and consequently it is difficult to harvest sufficient number of mature fruits from a small area at one picking. Harvesting costs could be reduced considerably if the plants are made to flower and mature the fruits uniformly in the rows. It is also desirable to have fruits of uniform maturity for canning.

An aqueous solution of acetylene gas has been known to induce early and uniform flowering within 6 to 8 weeks when applied to the growing point of the pineapple plant. Well grown plants having at least 30 leaves each are selected for the purpose, and into the heart of each plant is poured about 1/3rd cupful of a fresh solution of acetylene gas made by dissolving a handful of calcium carbide in four gallons of water in a tin. There should be no rain within forty-eight hours of application for the treatment to be effective, and no small plants should be treated as they will produce fruits of uneconomic size.



A row of Phyomone-treated pineapple suckers has come into bearing long before a row of untreated plants of the same age.

The more modern method of flower induction is by the application of hormones such as Alpha-naphthylacetic acid which are sold under various trade names. Apart from inducing early and uniform flowering the hormone also tends to delay fruit maturity and increase fruit size when sprayed on the fruit early in the season. It also helps to extend the season for pineapple and spread the harvesting operations.

Preliminary trials carried out with Alpha-naphthylacetic acid supplied under the trade name of Phyomone by the Imperial Chemical Industries (Export), Ltd., have given very promising results.

Three double rows of well grown pineapple plants were selected for the trial and each row of about 27 plants was treated with Phyomone, acetylene and fresh cow dung and urine, while the other row in the pair was left untreated as control. The following results were obtained 8 weeks after treatment.

	Phyomone	*Untreated*	*Acetylene*	*Untreated*	*Dung and urine*	*Untreated*
No. of plants	27	29	27	25	27	28
No. in flower after treatment	22	3	21	2	5	3
Percentage flowering	81	10	77	8	18	10

Both Acetylene and Phyomone have shown marked effect on flower induction, but not the fresh liquid manure. Further trials are being carried out using larger number of plants to study their influence on sucker production as well.

A. V. RICHARDS.

Response to Manuring and Methods of Planting in Sweet Potato

I. A set of 32 plots each 6 feet × 30 feet were subjected to two methods of planting and two methods of application of manure. The planting was done on ridges prepared by the use of a mould board plough. Planting Sweet Potato cutting across the ridge at right angles to it was compared with vertical planting of cuttings on top of the ridge. Two cuttings were planted at each point. In the first instance the two cuttings were planted with their apical ends facing opposite directions. The spacing between cuttings was one foot, the ridges being 2½ feet apart. Along with this, early application of manure —4 weeks after planting—was compared with late application of manure—8 weeks after planting. The fertilizer mixture of three hundred weights per acre consisted of 4 parts of sulphate of ammonia, two parts of super phosphate and two parts of muriate of potash. The results of the yields obtained were as tabulated below—

	Early application of manure and planting across	*Early application of manure and planting vertically*	*Late application of manure and planting across*	*Late application of manure and planting vertically*
Yield of tubers from 8 plots	667	600	635	539
Yield per acre in lb.	20,010	18,000	19,050	16,170

It apeared from the above results that planting across was superior to vertical planting and also that early application of manure gave better results than late applications.

II. In another group of 30 plots each 32 feet × 12 feet, four levels of the manure mixture in the same proportions as above were tried out against control plots. The fertilizer levels given to each set of five plots were as follows :—

(1) 1½ cwt. of the mixture per acre.
(2) 2 cwt. of the mixture per acre.
(3) 2½ cwt. of the mixture per acre.
(4) 3 cwt. of the mixture per acre.
(5) No manure (control).

The yields obtained were as indicated below —

Rate of Application per Acre	*1½ Cwt.*	*2 Cwt.*	*2½ Cwt.*	*3 Cwt.*	*Control*
No. of lb. of tubers from 6 plots	334	356	412	337	233

It was obvious from the results obtained that an application of 2½ cwts. of the manure mixture per acre gave better results than any of the other levels of the fertilizer mixture. On a rough estimate therefore an acre of sweet potato treated with this mixture at 2½ cwt. should yield twice the quantity of tubers that could be obtained from an unmanured area of the same extent.

K. J. GUNAWARDENA.

Departmental Notes

Botanic Gardens

Interchange of Plants and Seeds

THE Gardens have maintained the usual mutual exchanges with Governments in various parts of the world and private individuals. As a result our Orchid and Cactus collections have improved to a very large extent. The most noteworthy contributions were the following :—

1. 100 Seedlings of Cattleyas hybrids from Julius Roehrs of U. S. A.
2. Col. T. Y. Wright's whole collection of orchids.
3. 62 species mostly Botanicals from Dr. R. Paulin, Deputy Director, Scientific Institute, Madagascar, including mostly Jumelleas and Angraecums.
4. 12 plants of Cattleyas. Cypripediums and Cymbidiums from Messrs. Sanders of St. Albans.
5. 2 plants of *Vanda Sanderiana* from Oscar M. Kirch of Hawaii.
6. 320 seedlings of Orchid hybrids raised at Heneratgoda Botanic Gardens.
7. Over 192 species of Cacti from Germany, Spain and Portugal belonging to the Genera *Caralluma, Stapelia, Opuntia, Mammillaria, Neomammillaria, Echinopsis Echinocactus, Echinocereus, Eriocereus, Trichocereus, Haagocereus, Hylocereus Pilocereus, Cereus, Astrophytum, Horridocactus Cleistocactus, Rebutia, Lobivia, Pseudolobivia, Harrisia, Gymnocalycinus* and *Aloe*.

The white Bougainvillaea sent from the Botanic Gardens, Singapore, and Department of Agriculture, Trinidad, is greatly admired and much in demand.

Sixty-one named Begonia varieties and thirty Achimenes varieties were received from Maurice Mason of England.

Of much interest as a hedge plant which keeps away cattle is *Rosa multiflora* from Maryland. Plants are being propagated vegetatively for early distribution. It would in time replace barbed wire fencing in farms.

A package of Aroids was received from Leon W. Frost of Florida and seed of *Victoria cruciana* a water lily which is easily propagated and gaining much popularity from University Botanic Gardens, Bonn, Germany.

In exchange the Gardens have sent out plants and seeds of tropical ornamental varieties to those institutions.

Plant Breeding

Hybridisation of Orchids and Anthuriums is being conducted vigorously and it is hoped to make plants of these available to the public shortly.

D. M. A. JAYAWEERA

Book Reviews

Small Farm Implements—by H. J. Hopfen and E. Biesalksi, F. A. O. Development Paper No. 32, 1953

This is the age of mechanization of agriculture when farming operations are being speeded up and are being made less dependent on hand and animal labour by the introduction of power drawn implements and machinery. Tillage with tractors and the harvesting, threshing and winnowing of grain crops by the combine are now a commonplace with the farmers of the more advanced countries in the West. Implements of improved design for earth moving and other operations on the land are being manufactured. Even in market gardening and small allotments, hand operated

implements and tools involving less physical effort are being introduced. The index of a country's agricultural progress can be gauged by the efficiency of the implements in use. The peasant farmer in the tropics, however, has made little advance and he continues to use, for the most part, traditional implements with little or no improvement.

In response to a request from member countries, F. A. O. has prepared a booklet entitled "Small Farm Implements" by H. J. Hopfen and E. Biesalksi of the Land and Water Use branch of the Agriculture division. It is based on the replies to a questionnaire on implements and small machines sent out in July, 1951, to a number of institutes, officers, manufacturers and private individuals in different countries. An attempt has been made to describe a number of the better types of implements and small machines which have been developed in some countries but which are little known in others so that this information can be made available to all member countries. This was a commendable task and it recalls to mind the words of a former Director-General of F. A. O., Mr. Norris E. Dodd, when in an article on "Hoes and 'Show How' Come First" published in the New York Times Magazine of October 2, 1949, he said that "there are plenty of places, remember, where just a good hoe is an advanced agricultural implement."

Many of the under-developed countries where little or no change has taken place over the centuries in the type of implement used will welcome this publication of F. A. O. They will learn therein that there are, for instance, thousands of types of hoes in their basic form of an iron blade and handle whose performance is poor and that these differences are largely due to "local preferences, which have little or nothing to do with useful adaptations to special local conditions."

There are sections devoted to tools for tillage, sowing, planting, fertilizing, harvesting and processing and finally to equipment for transportation including windlasses and hand pumps. There is also a list of selected references. The booklet is well illustrated with 120 figures of photographs and drawings some of which might have been scaled.

Much of the information furnished in this important publication is too brief and it is to be hoped that in the next edition a fuller account will appear of all implements, tools and machines which are considered to be most efficient and suitable for adoption by those countries where they are little known.

W. R. C. P.

"Mammalian Hybrids—A check-list with Bibliography" by Annie P. Gray

(Technical Communication No. 10 of the Commonwealth Bureau of Animal Breeding & Genetics, Edinburgh)

Crosses between species or genera are usually (but not always) impossible, or, if possible, are usually sterile, because the two sets of genes are so different that they will not work together harmoniously in producing their physiological effects. To practical taxonomists, this has been one of the major criteria for determining whether two groups are really distinct species or genera.

But, wherever generic crosses and species hybrids are possible, attempts have been made to utilise them for economic purposes, though not to as great an extent in the Animal as in the Plant Kingdom. The mule is a commercially important hybrid in North America, while crosses between Zebu Cattle and cattle breeds of European origin are fast gaining economic importance in the tropics. Annie Gray's volume on Mammalian hybrids provides complete check-list of all recorded attempts to hybridise different Mammalian groups and incorporates some valuable information on the fertility and commercial qualities of such hybrids. The index of species and the bibliography of more than 600 titles which this volume contains should also prove valuable to zoologists generally and mammalogists and geneticists in particular.

P. M.

A Report on Cocoa Research 1945-1951
St. Augustine, Trinidad B.W.1,
Price 25 Shillings

This is a lucid and comprehensive report on cocoa research in progress during 1945-1951 at the Imperial College of Tropical Agriculture, Trinidad, under the West-Indies Cocoa Research Scheme, financed jointly by the British Government and the Cocoa, Chocolate and Confectionery Alliance, U.S., since 1947, and administered and directed by the College Authorities. The first report of the Cocoa Research Scheme, which was originally financed by the cocoa and chocolate manufacturers in the United Kingdom, was published in 1932, and subsequent reports appeared annually until 1944 when the 11th report was published, and further work curtailed by war-time restrictions. Two short interim reports were issued in 1945 and 1946.

There are in this report no less than 27 separate contributions by nearly every member of the full-time graduate staff consisting of two plant breeders, two plant-physiologists, two soil chemists, one biochemist, one entomologist, one plant pathologist and two field officers, besides the professors and senior lecturers of the college staff who were closely associated with the scheme and actually participated in the work.

The introduction to the report is written by the Principal and Director of Research, Mr. H. J. Page, C.M.G., O.B.E., who outlines the programme of research on hand and summarises briefly for the benefit of the general reader the results presented in the several communications which are grouped by him under the five main headings, 1. Selection, breeding and propagation of cacao, 2. Soils and nutritional factors, 3. Other environmental factors, 4. Pests and diseases of cacao, 5. Preparation and quality of cocoa.

Of particular interest to the plant breeder and cacao grower is the report on the performance of the clonal projeny of the hundred mother trees, KS 1-100 originally selected in Trinidad and Tobago by the late Dr. Pound, and planted for trial on two estates under different soil conditions. While many clones were good yielders at both estates, and others poor yielders, there were some which were good yielders at one estate but poor yielders at the other, and vice versa, indicating thereby that "the relative merits of different clones are influenced by local conditions of soil, climate, &c., and the best clones for any given set of conditions can be ascertained with certainty only by trials in the area concerned." It is however significant that this clone KS 1 has given the highest yield in almost all the trials in which it was included. This clone together with the other high-yielding KS clones were recently introduced into Ceylon from Kew and their performance is being watched with interest. Another significant observation was the tendency for the good clones to do better as rooted cuttings than buddings although the differences became less marked with age. The poor clones often did well as buddings than rooted cuttings, while in the case of others showing delayed promise buddings characteristically out-yielded the cuttings.

The various factors which influence the large-scale propagation of cacao by rooted cuttings are discussed in detail with special reference to the optimum light intensity, atmoshperic humidity, temperature, type of cutting, composition of the rooting mediums, &c., and the techniques of striking cuttings in closed bins of the Trinidad type and in open beds under continuous mist sprays are described.

Other items of special interest to the cacao grower in Ceylon are the photographs and attractive colour illustrations of mineral deficiencies in cacao, particularly the symptoms of sickle leaf disease which are not unlike those found on cacao is the Dumbara valley, the record of spread of the Trinidad strains of cacao virus disease which cause an appreciable and progressive reduction in yield though not the spectacular death of the trees as in the case of the virulent strains of "swollen shoot" virus in West Africa, and the analysis of the factors responsible for the deterioration of cacao soils in Trinidad where a crop of 500 lb. of cacao per acre is estimated to remove from the soil 12 lb. N, 6 lb. P_2O_5 and 9½ lb. K_2O.

The Principal and Research staff are to be congratulated on the compilation of this progress report which contains a wealth of information that will be of interest and value to cacao growers and others engaged on cacao research throughout the world. Credit is also due to the Cocoa, Chocalate & Confectionery Alliance, Ltd., 11, Green Street, London, W.1, for having arranged and supervised the printing of the report in which the few printers' errors are corrected on a separate sheet attached to it.

A. V. R.

Central Board of Agriculture

Proceedings of the Fifth Meeting held at the School of Agriculture, Peradeniya, on December 7, 1953

Dr. A. W. R. JOACHIM, Director of Agriculture, presided and the following were present :—Mr. C. A. M. de Silva (Vice-Chairman); Mr. R. T. Chelliah; Mr. N. R. Rajavarothiam, M.P.; Mr. N H. Keerthiratne, M.P., Parliamentary Secretary ; Mr. H. S. Wanasinghe, C.C.S., representing the Director of Rural Development ; Major E. C. de Fonseka, M.B.E., E.D.; Gate Mudliyar Arthur D. S. Jayasinghe ; Mr. F. A. Wickremasuriya ; Mr. H. Abeygoonesekera, D.R.O.; Mr. Henry Abeywickrema, M.P.; Mr. S. Vytilingam, M.P.; Mr. K. Kanagaratnam ; Dr. H. E. Young, Director, Rubber Research Institute ; Mr. H. A. Pieris ; Mr. A. M. Clement Dias ; Mr. Anton C. Ponnampalam ; Mr. S. L. Bandara Dharmakirti, J.P.; Mr. W. M. Kumarasamy ; Sir James P. Obeyesekera ; Gate Mudliyar N. Wickremaratne ; Mr. S. Sivapalan ; Muhandiram S. Armstrong ; Mr. T. B. Narampanawa, D.R.O.; Mr. A. Perumynar, D.R.O.; Mr. A. W. R. Perera, Assistant Commissioner for Development of Marketing, representing C.D.M.; Mr. W. D. O. Tillekeratne, A.C.D.M., for C.D.M.; Mr. K. W. Devanayagam ; Mr. L. S. Boys; Mr. Chas. A. M. de Silva ; Mr. J. M. Sabaratnam, D.R.O. ; Mr. V. G. W. Ratnayake, M.P.; Dissawa H. B. Rambukwella, M.P.; Mr. Albert Godamunne ; and Mr. A. J. Joseph, C.C.S., Assistant Director of Agriculture (Administration), Secretary.

The following officials of the Department were present by invitation : Mr. C. N. E. J. de Mel, Deputy Director of Agriculture ; Dr. W. R. C. Paul, Assistant Director of Agriculture (Technical); Dr. J. W. L. Peiris, Plant Pathologist ; Mr. A. V. Richards, Horticultural Officer ; Dr. H. E. Fernando, Entomologist ; Mr. L. H. Fernando, Botanist and S. A. R. O.; Mr. M. L. C. Illangakoon, Principal, School of Agriculture ; and Mr. S. B. Yatawara, Agricultural Officer (Propaganda).

The following visitors were also present :—

Mr. A. H. Imhoff, F. A. O. Expert in Extension Publicity, and Mr. T. C. de Sylva.

Letters and telegrams regretting inability to attend the meeting were received from the following :—

Dissawa C. B. Nugawala ; Mr. A. H. T. de Soysa ; Mr. H. E. Tennekoon, Land Commissioner ; Mr. G. K. Newton ; Mr. W. T. I. Alagaratnam, Director of Irrigation ; Mr. F. C. Cooke, Director, Coconut Research Institute ; Sir Wilfrid de Soysa ; Mr. S. Pararajasingham ; Mr. M. Sri Kantha, Director of Land Development ; Mr. K. Morford, C.B.E., J.P.; Mr. S. A. Selvanayagam, O.B.E.; Mr. S. C. Fernando, Commissioner, Co-operative Development and Registrar of Co-operative Societies ; Mr. R. H. Spencer Schrader, J.P., U.M.; Mr. J. Lamb, Director, Tea Research Institute ; Senator Lady Molamure, O.B.E.; Senator Justin Kotelawela ; Mr. Gladwin

Kotelawela, M.B.E.; Mr. Thomas Amarasuriya; Mr. S. Pathmanathan; Miss Cissy Cooray; Mudliyar Abdul Cassim Marikar; Mr. M. Senanayake, M.P.; Mr. T. C. Rajaratnam, J.P., U.M., O.B.E.; Mr. M. B. Samarakoon, D. R. O., Buttala; Mr. S. M. Rasamanickkam, M.P., Mr. U. B. Unamboowe, J.P., O.B.E., M.P.; Mr. E. Muthukumaran; and Mr. E. W. Kannangara.

I. Confirmation of Minutes of last Meeting

The minutes of the last meeting of the Central Board of Agriculture were unanimously confirmed.

Chairman—" Gentlemen, in the first instance I should submit an explanation for the change of the venue of our meeting. This has been occasioned by the fact that the usual meeting place in the Gardens has now been claimed by the Agricultural Officer (Propaganda) for his Propaganda Museum and Propaganda Room. We had such a room in Kandy but for reasons of economy we have decided to close it down and the Agricultural Officer (Propaganda) found himself with no other place except the Board Room to house his exhibits. We have accordingly had to resort to this room, which is a much nicer room, though a bit difficult to get to. We shall make it as little inconvenient as possible to members to get here, especially those who do not bring their cars. If any gentleman has been inconvenienced by the change of venue for today's meeting, I offer my apologies. Our new Secretary, Mr. A. J. Joseph, has been very resourceful and has kindly arranged for the conveyance of members to-day ".

At this stage Gate Mudliyar N. Wickremaratne inquired whether the Co-operative Department was represented at the meeting since marketing, transport and supply of vegetables would come up for discussion at the meeting.

Since there was no representative from the Co-operative Department, Mr. N. H. Keerthiratne, M.P. and Parliamentary Secretary to the Ministry of Posts and Information suggested that in future all Departments should be represented at the meeting and if a Head of a Department was unable to be present, he should be requested to send a representative.

The Chairman replied that he would bring that to the notice of the officers concerned.

II. Matters arising from Minutes

Chairman—" At an earlier meeting of the Central Board of Agriculture held on May 11, 1953, when the subject of pasture was discussed, Mr. R. H. Spencer Schrader suggested that a small Sub-Committee be appointed to consider popular names for our local grasses. These minutes have now been approved, and I think it would be useful if members could suggest a few names of people who are really interested in this subject who would form a Sub-Committee to go into this matter.

I would suggest that Mr. Spencer Schrader and Major Fonseka should be included in this Committee.

On the proposals of various members, the following Sub-Committee was appointed under the Chairmanship of Dr. W. R. C. Paul, Assistant Director, to consider popular names for the local grasses of the Island :—

Dr. W. R. C. Paul (Chairman)
Mr. R. H. Spencer Schrader
Major E. C. de Fonseka
Mr. W. M. Coomaraswamy
Sir James P. Obeyesekera
Gate Mudliyar N. Wickremaratne
Mr. S. Sivapalan
Mr. A. M. Clement Dias

The Chairman suggested that Mr. J. E. Seneratne, Systematic Botanist of the Department, should also be co-operated to the Sub-Committee.

Chairman—" In regard to action taken by the Ministry on the proposals put forward at the second meeting of the Central Board of Agriculture, held on February 16, 1953, a cyclostyled memo. has already been circulated among members. If you will remember, I indicated to you that the line of action I was going to follow would be to send to the Ministry at the end of every meeting,

after minutes were confirmed, a copy of the full minutes of the meeting together with a summary of the proposals made at the meeting. The decisions of the Ministry in regard to our proposals are given in this cyclostyled sheet. They represent the Ministry's view on the various matters discussed. Your proposals on Animal Husbandry development in the Island have already been sent to the Ministry and are under consideration by it.

I would like to refer to just one point in the discussion on Food Production, viz., the proposal in regard to a Paddy Research Institute. That was brought up by Mr. V. G. W. Ratnayake, M.P., who suggested that a Paddy Research Institute should be established in the Island. The reply of the Ministry is that 'it is not proposed to establish such an Institute for the present. The Department carries out the necessary research.' I should like to explain here that a very great part of the work of the Department on crop husbandry deals with the paddy crop. We have engaged on such work six Agricultural Research Officers besides the Botanist and the Assistant Botanist. Further, various Research Divisions like the Pathological Division, Entomological Division, Chemical Division, &c., are concerned to a large extent with the problems of paddy. It has, therefore to be emphasised that the whole Department of Agriculture can be considered a Research Institute for paddy and hence the Ministry's reply. We have, however, scope for the establishment of one or two large Paddy Research Stations, in addition to the ones we already have. Batalagoda is our largest Paddy Research Station, but it is proposed to extend the facilities on this station very considerably as soon as funds are available. This has been one of our major proposals in the Five Year Plan which we submitted to Government for consideration, and I am certain that even if our other proposals are rejected, our request for facilities for research in paddy cultivation would be given high priority".

At this stage Mr. S. Sivapalan emphatically stated :—"I would like to draw your attention and that of the Board to the matter referred to in paragraph 17, namely, that land should be alienated to middle-class persons and capitalists for paddy cultivation. This matter has been unsettled for several decades. You remember, that in the first meeting of the Central Board of Agriculture, there was a desire on the part of many members to go into this matter and requested you to call a special meeting of this Board to discuss this question. I find that it has been subsequently left out and the only reply from the Ministry is that it has been referred to the Permanent Secretary, Ministry of Lands and Land Development, for necessary action. It is an extremely important question on which depends the whole country's economy, and at a time when the whole country is talking of Food Production, officers responsible may be told of the urgency of this matter".

Major E. C. de Fonseka thanked the Chairman for making available to every member of the Board a summary of the replies received from the Ministry in regard to the proposals put up by them. He said that while being thankful to the Chairman he would request that the abbreviations in that paper be explained because being non-Government officers they were not familiar with such abbreviations.

The Chairman explained the abbreviations and agreed that they should have been typed in full.

Mudliyar Armstrong—"In regard to items 1 and 2 of the paper circulated, recommending the levelling of 60,000 acres of paddy land in the Eastern Province for the easy flow of water, the reply given by the Ministry is that all Major Schemes have channel systems and all tanks restored are provided with irrigation facilities. I have already stated, if you will refer to the minutes of the 2nd Meeting, that there are 23 Major Irrigation Schemes in the Batticaloa District and that these tanks serve 60,000 acres under these schemes. It is very unfortunate that the Director of Irrigation is not to be found here, I would like to say that except for Rufusculam, the only one which is in a muddle, all the other tanks have been restored but not constructed as the ancient people had done, but they are lying as they are and the water is allowed to flow by nature through sandy ————. We have seen that

about 30 to 40 per cent. of the water in that tank goes waste into the lagoon. Therefore my point was that the channels leading from such schemes were not sufficiently opened up by the Irrigation Department and that some of the existing channels should be modernised. But the colouring given in the answer is something like a sugar-coated pill, that all channels are given irrigation facilities. What are these irrigation facilities? Your representative in the Eastern Province would have told you what these facilities are. It is the modernisation of the existing channel system that we want under these schemes. We know that the Ceylon Government has no funds, but it can be taken up one by one piecemeal and it is not a matter to be answered in three lines.

Apart from that, in my comments at the 2nd Meeting of the Board, I have mentioned in the 2nd para. that there was no easy flow of water from one field to the other and as a result transplanting became a failure and that although there were 60,000 acres under Major Schemes, the fields were not levelled. That is an entirely different matter and the answer given by the Ministry has no relation to that point".

At this stage, Mr. N. H. Keerthiratne, M.P. and Parliamentary Secretary, inquired whether the fields referred to were Government or private owned.

Mudliyar Armstrong replied that about 75 per cent. of them were private owned.

Mr. Anton C. Ponnampalam suggested that for levelling purposes, tractors could be hired from C. A. P. and S. Societies, or if there was a shortage of tractors, contour ridging of paddy fields should be done.

Mudliyar Armstrong emphasized that his point was that the question raised by him in regard to this matter had not been answered.

Mr. Anton C. Ponnampalam suggested that the Chairman might send Mudliyar Armstrong's proposals in question to the various Departments for their correct answers and table them at the next meeting if possible.

Mr. Ponnampalam also suggested that since private enterprise and Government owned lands came into the question at issue, it would be best if Mudaliyar Armstrong could discuss the problem with the Director of Irrigation.

Mudaliyar Armstrong replied that he had already suggested in two paragraphs at the second meeting of the Board what should be done in regard to irrigation and modernisation of the channels and levelling of the fields. Levelling of the fields was an entirely different matter and he had already expressed that the tractors owned by C. A. P. & S. Societies were not suitable for the purpose as they were rubber tyred tractors whereas caterpillar tractors were the only ones suitable for the levelling of fields.

Mr. A. M. Clement Dias referring to a leaflet on paddy issued by the Department said he was very happy that it contained such useful information and wished that it be published in Sinhalese as well.

Mr. Dias also remarked that he had once applied to the Department for two bushels of PTB 16, a pureline variety of paddy, but the Department had issued only two measures out of which he had harvested 60 measures. He said that he was glad to state that he was now in a position to issue two measures of that variety to each of his cultivators.

Gate Mudaliyar N. Wickremaratne drew the attention of the Board to a statement by the Irrigation Department which had appeared in headlines in the Press that cultivators were wasting a good deal of water. He added that unfortunately the Director of Irrigation was not present at the meeting, otherwise he would have asked him to prove that statement.

III. Discussion on "Process of Horticultural Development in the Island"

Mr. A. V. Richards, Horticultural Officer—

"Mr. Chairman and Gentlemen—It gives me great pleasure to be present here with you this afternoon and to have the opportunity of initiating a discussion on the two subjects on the agenda, namely, the progress of horticultural development in the Island, and cacao research.

Before I proceed with the discussion I wish to mention that the Horticultural Division responsible for this work was created as a separate Division in January, 1941, with the appointment of a full-time Horticultural Officer. Owing to the limited staff attached to the Division, much of the work, especially relating to the extension side, such as issue of planting material to colonists, &c., has been done in collaboration with the Agricultural Officers and their staff and my thanks are due to them for the co-operation extended.

As you are aware, wide regional variations in soil and climate within relatively short distances make it possible for us in Ceylon to grow a great variety of fruits ranging from tropical to subtropical and even temperate zone deciduous fruits such as plums and pears. The climatic zones in which they are grown consist of the low-country wet, dry and semi-dry zones, the mid-country wet and semi-dry zones and the up-country wet zone at an elevation of over 3,500 feet.

These regional variations in soil and climate not only enable a great diversity of fruits to be grown but they also influence fruit quality, particularly the colour and flavour, and help to extend the season of fruiting. The use of early, mid-season and late maturing varieties of fruit also helps to extend the fruiting season and thereby reduce losses caused by seasonal gluts.

Thus with one variety of grapefruit, the Marsh Seedless, grown in four climatic zones in California, the picking season starts in November in the low-elevation desert region where the winters are mild and the summers intensely hot and ends the following October in the southern coastal belt where the summers are moderately cool and the winters mild. The fruit grown in the desert region has a better flavour and colour than the fruit grown in the coastal belt where it tends to be more acid and bitter.

Similarly by growing two varieties of sweet orange the early maturing Washington Naval and the late maturing Valencia in three climatic zones, early, intermediate and late, Californian growers are able to pick oranges nearly all the year round.

In the main citrus growing areas on the Murray and Murrumbidgee rivers in Australia the early Washington Naval and late Valencia are grown, but further north in subtropical Queensland a mid-season variety, the Joppa, is also grown. The growing of an early variety in an early district and a late variety in a late district enables the season to be extended considerably.

In Ceylon the Vavuniya sweet orange makes a good desert orange and is recommended for planting as an early variety. The seedless Bibile sweet orange, which is almost seedless, thin skinned and juicy, makes an excellent squash orange and comes into maturity late in the season in July-August. It often produces an off-season crop in November-December. With both these varieties the fruit could be held on the tree in good condition three to four months longer in the season, but the fruit fly and fruit piercing moths are so destructive on late season fruit and difficult to control that growers are compelled to pick the fruit at the earliest opportunity.

The study of the bearing habit of mango varieties has shown that the early Jaffna or Vellaicolomban, the mid-season Willard and Karuthacolomban and the late Ambalavi and Neelam come into season in the Jaffna and Puttalam Districts from about May to August, but at Hingurakgoda and most other places in the dry zone the main season for these varieties is from November to January though they mature in about the same order.

In the case of Avocado which is a fruit of high nutritive value the present practice is to plant varieties which come into season at different periods in the year. Of the successful introductions into Ceylon the Gottfried and Puebla are early, Pollock and Trapp are mild season and St. Anne is late. The more recent introductions consist of hard shelled varieties such as Nabel and Linda from Hawaii where they are reputed to be resistant to attack by the fruit fly and Helopeltis bug, but their fruiting habit here is not known as the plants are still too young.

The jak is an important food crop in the rural areas where it is not uncommon for the poorer classes to live on it during the

season. The fruit is used in various stages of maturity for cooking, and the ripe *peniwaraka* itself is esteemed as a dessert especially in the Jaffna Peninsula where choice varieties are grown. The tree is a valuable source of timber and the leaves are relished by cattle and goats. The extension of the season for jak has been made possible in recent years by the introduction and multiplication of the Singapore jak which comes into bearing within 18 to 24 months seed in favourable localities in the wet zone, and is in season for about November to February when the local jak is not in fruit. It also produces a small crop from May to July when the local jak is in season. Dusting the young fruit with Gammexane once or twice is effective against attack by the jak-fruit borer.

The local pear is in season at Nuwara Eliya in April-May but within a few miles at Hakgala which gets more of the North-East than the South-West monsoon the season is in August-September. Citrus fruits produced in the mid-country semi-dry areas at Welimada or Hewaheta colour naturally on the tree long before they are quite mature and are more acid than the low-country fruit.

The study of these differences in fruiting habits has been of value in recent years in planning a programme of development which will ensure a regular supply of fruit nearly all the year round. The selection of suitable varieties for planting was facilitated by the appointment of a Fruit Tasting Committee which expressed its opinion on the flavour and quality of fruits obtained from individual parent trees. In this connection I wish to place on record our appreciation of the co-operation and generosity of those private growers, some of whom are members of the Board of Agriculture, who allowed us to remove budwood free of charge from their selected trees which were approved by the Fruit Tasting Committee. Budwood of Nagpur Santra mandarin, Indian orange and Neelam mango was obtained from Mr. Marcus S. Rockwood's Achchithotam, British Guiana lime and Vavuniya sweet orange from Mr. Swaminather's orchard at Omantai, Japanese Persimmon from Guruthalawa farm, another strain of Neelam from Mrs. Gunasekera's garden at Bambalapitiya. Successful introductions made recently from abroad are Haden mango from Hawaii, Kensington mango and a hybrid of custard apple and Cherimoyer called Pinks Mammoth Custard apple from Queensland, Ohanez grapevine and Avocado varieties from New South Wales, and the seedless pomegranate from Bangalore. In most cases only budwood was imported by air and successfully worked on local rootstocks.

Stock-scion Relationships

With few exceptions choice varieties of tree fruits are propagated vegetatively by budgrafting on compatible rootstocks. In recent years considerable progress has been made in the evaluation of stock-scion relationships especially in respect of citrus.

The sour orange stock on which over 75 per cent. of the world's citrus was at one time grown has in recent years proved to be a failure in California, Brazil, and Australia owing to the occurrence of a virus disease which causes the death of the scion varieties budgrafted on it. Over eight million sweet orange trees are estimated to have been killed in South America by this virus which appears to continue its destructive work unchecked and is a potential menace to citrus in Trinidad, Spain and other Mediterranean countries where nearly all the citrus trees are on sour orange stock.

The failure of sweet orange on sour orange stock was first observed in South Africa as far back as 1899, and was cited as a classic example of stock-scion incompatibility.

Transmission experiments carried out in recent years has shown that it is not stock-scion incompatibility but a virus that is responsible for the failure.

The unsuitability of sour orange which had been recommended in the early days as a root stock for citrus in the wet zone in Ceylon was demonstrated by the Horticultural Division from the results of stock-scion trials carried out at Peradeniya, Hingurakgoda, Nalanda and Moneragala. The pummelo which had also been previously recommended was found to be equally unsuitable.

Of the two stocks, rough lemon and sweet orange, on which most citrus varieties have made healthy growth, the former is suitable for the light sandy soils in the dry zone, but fruit quality is not of the best in the early years since it is known to depress the sugar and acid content for the first five or six years. Moreover in recent years stem pitting which is believed to be a different symptom expression of the Tristeza Quick Decline virus complex has been found to occur on citrus trees worked on this stock. It has wiped out the grapefruit industry in Queensland and is widespread in South Africa. The failure of the imported grapefruit trees which showed great promise under irrigation at Hingurakgoda at the start is now thought to be largely due to the ravages of this Stem-pitting virus since the commercial nursery at Benyenda Queensland from where they were obtained was subsequently found to be a hot bed of virus and had to be closed down.

Trees on sweet orange stock may be slow in growth at the start but catch up with the trees on rough lemon stock in five to six years and later surpass them in vigour of growth and yield, and are likely to survive longer. Fruit quality from the start is particularly high on sweet orange stock and a further point in its favour is that even if the scion were to die as it often happens when budgrafted trees are planted in village gardens and colonists allotments the stock will grow and produce sweet oranges which are acceptable. That would not be so, if the stock used were rough lemon or sweet orange. Both rough lemon and sweet orange are however susceptible to Phytophthora root rot on poorly drained soils. Trees growing on irrigable land below the level of the tank bed often become chlorotic and unhealthy at the end of the rainy season owing to the death of the feeding roots caused by the rise of water table during the rainy season. The Trifoliata orange and its hybrids with sweet orange, Morton and Troyer citrange have attracted attention in recent years as possible root-stocks for citrus in California and Australia in view of their resistance to Phytophthora root rot and eel worm. Fruit quality is also high on Trifoliata stock since it increases both sugar and acid content of the juice, the fruits hang well long after maturity, and the storage life after picking is also longer than that of fruit produced on other root-stocks.

Both Trifoliata and Morton citrange have been successfully introduced into Ceylon but the plants have taken over two years to be ready for budding and it remains to be seen whether they would make good rootstocks under local conditions. Other stocks which show promise in the trials are *Patharan* for grapefruit, *Heen naran* for sweet orange and *Jama naran* for mandarin.

The occurrence of polyembryony in mango makes it possible as in the case of citrus to produce nucellar stock of uniform genetic make-up for budgrafting, and the two polyembryonic varieties *Kohuamba* and *Bettiamba* used in the mango stock-scion trial at Dambulla make the best rootstocks for Jaffna, Willard, Sabre and Ambalavi mangoes. The monoembryonic *Etamba* and *Walamba* display considerable variability in the growth of seedling stocks. A recent development is the use of polyembryonic Jaffna and Karuthacolomban as stock for mango at Hingurakgoda where the fruits from the hundred acre mango orchard are canned on the spot and the seed made available for raising stocks. The growth of the mango varieties on these vigorous stocks shows promise. The local *palu* has been found to make a good stock for Sapodilla though it takes nearly two years to be ready for budding and is difficult to transplant. The *mee* shows considerable variability and in many cases the stock overgrows the scion and symptoms of delayed incompatibility develop in due course.

Developments in Orchard Practice

The normal routine practice in many orchards is to grow a green manure crop with the rains, and disc it in before the beginning of the dry season when the land is clean cultivated to produce a soil mulch. The removal of all weed growth helps to conserve soil moisture, and eliminates competition for nutrients particularly nitrogen. But continuous clean cultivation tends to destroy organic matter and soil

structure, retards penetration of moisture into the soil by the formation of a hard pan and injures the lateral feeding roots which in the case of citrus are generally found at shallow depths. The alternatives to clean cultivation which are being given a trial are—

1. No cultivation. 2. Reduce summer cultivation. 3. Cultivation only alternate strips. 4. Sod culture using grass and legumes such as *Desmodium unicinatum* and Calapagonium.

A non-climbing leguminous cover such as *Desmodium* or *Stylosanthes gracilis* is easy to establish in orchards in the wet and semi-dry zones where sufficient soil moisture is generally available for both the cover crop and the trees, but it is difficult to find a suitable leguminous cover which will withstand drought and pest attack in the dry zone and at the same time not compete unduly with the trees for soil moisture during the long dry periods. The present practice is not to clean cultivate but slash or mow the weeds before they run to seed and mulch a circular area immediately round the trees with cut grass and other organic matter.

The practice of keeping poultry in citrus orchards is a recent development which has been found to be very effective in improving the health and vigour of the trees and increasing their yield. About 75 to 100 birds per acre are given free range and provided with portable houses containing nests for laying eggs. The advantages claimed for this practice are (1) Effective control of weeds by the poultry and hence lower cultivation costs. (2) Improved tree vigour and cropping through the incorporation of poultry manure into the soil in addition to the normal fertilizer mixture, and (3) better retention of soil moisture in summer months through effective weed control. Against these are the disadvantages of having to pay special attention to the poultry which cannot be neglected even for short. periods and the risk of increase in scale pests on trees subject to dust near the poultry houses.

If smaller pens are provided as was done recently at the Citrus Station, Bibile, the birds are likely to cause the lateral feeding roots under the trees to be exposed by scratching the soil which has to be put back periodically. Nevertheless the improvements in tree vigour and colour of foliage was remarkable and many of the trees especially mandarins produced bumper crops during the season.

Pest and Disease Control

While fungicide containing sulphur are effective in controlling citrus mildew and sooty mould there is no effective cure available for pink disease which probably causes the most amount of damage to citrus in the principal citrus growing areas at Bibile. Prevention here is better than the cure, and emphasis is placed on orchard sanitation.

Besides D.D.T. and Gammexane which are used as contact sprays and against which some new generation of insect pests have developed appreciable resistance a whole array of organic phosphorous compounds are now available for use as systematic insecticides. These substances are readily absorbed by the plant and only the insect pests that feed on the sap rendered toxic by the insecticide are promptly killed and not the beneficial parasites and predators which control these pests in nature. But being highly toxic they cannot be used on edible fruit for the control of the fruit fly and the fruit piercing moths which are the two most destructive pests limiting fruit production in Ceylon and for which no satisfactory control measures are yet available.

Horticultural Development

As stated by me recently in my Presidential address to the Agriculture and Forestry section of the Ceylon Association for advancement of Science the growing of fruit as a mixed garden crop in rural areas is a characteristic feature of horticulture in Ceylon. Besides pests and disease other hazards such as unseasonal rains, drought, &c., make it difficult for a family with moderate means to earn a living by growing fruit alone except in certain favourable localities in Bibile area where the soil and climatic

conditions are suitable for the commercial production of a large variety of fruits such as mango, citrus, banana, pineapple and papaw. For best results fruit growing has to be combined with animal husbandry and arable farming. The Jaffna farmer makes a substantial living by growing bananas in rotation with other irrigated crops such as tobacco, manioc, millet, green gram, chillies and onions, and selling most of the fruit through the Co-operative Agricultural Produce and Sales Societies to the Marketing Department Hospital Supply Scheme. The banana gardens are heavily fertilised by penning cattle around portable stalls placed between tree rows, and cropped for five to ten or more years. Bananas are now grown more extensively in other parts of the Island as intercrops in young orchards and plantations, and in highland allotments.

Government policy in recent years has been to encourage the cultivation of fruit on highland allotments in the colonisation and irrigation schemes, and in existing home gardens in villages by the free issue of selected clonal planting materials of high quality to colonists and needy villagers. Fruits such as jak, banana, guava and breadfruit which are of high food value are grown to supplement the diet, while pineapple, papaw, mango, citrus and pomegranate serve as cash crops. Flourishing fruit gardens are to be seen in some of the colonists highland allotments each varying from 1½ to 3 acres under the Minipe Yoda Ela, Parakkrama Samudra, Kagama and other major irrigation schemes. Large quantities of planting materials have also been made available in connection with the citrus and jak planting drives. The Committee appointed by Government to advise on the utilization of Crown lands has in its report issued as Sessional Paper III of March, 1953, reviewed the progress made in the existing co-operative Dry Farming Schemes for peasants in which each family is provided with a two-acre homestead to grow fruit and vegetables and 12 acres of farm land for mixed farming on the alternate husbandry system with arable crops and livestock. For persons with moderate means a 75-acre mixed farming unit with a 10-acre homestead for fruit and vegetables, and for capitalists a 350-acre mixed farming unit with 50 acres for orchard crops are recommended. The Committee has stressed that the area for orchard crops should preferably be situated close to a tank and on the upper reaches of it in order to provide lift irrigation and minimise the risk of water logging. Poultry would be incorporated into this scheme on free range to produce table eggs and fatten birds for the poultry markets, and bee-keeping would be attempted as a side line.

The Committee has also referred to the possibilities of large scale fruit farming in the dry zone on the lines recommended by the Fruit Development Committee in Sessional Paper XX of August, 1941. It is of opinion that the Department of Agriculture has in several cases succeeded in establishing fruit farming on an economic scale, and therefore recommends that immediate action be taken to encourage the lease of Crown lands for fruit cultivation on an orchard scale to interested private agencies.

The World Bank Mission which examined recently the various Agricultural and Industrial projects in the Island has also recommended the extension of the acreage under mango and pineapple with a view to canning the produce. It considered fruit to be a source of food that could be greatly increased in both quality and quantity under the good growing conditions in various parts of the Island. The successful implementation of these various schemes and the application of modern methods of orchard development for the increased production of fruit of high quality should in no small measure help the nation not only to grow more fruit but to eat more fruit and better fruit for good health.

The Chairman called for the observations of members on the subject at the conclusion of Mr. Richards' talk.

Gate Mudliyar N. Wickremaratne stated that in 1935 he had planted out some grafted orange and lime. All the orange plants had died while only one lime plant survived which started bearing well and was able to get a good crop.

As regards mangoes, Gate Mudliyar Wickremaratne said that he was almost definite that two crops of mangoes in one year were

possible at Hingurakgoda. He added that out of some ordinary varieties of mangoes he had planted out, like "Dampara", he was able to harvest two crops in one year. He had asked several officers whether it was not a possibility to get two crops in one year in the case of mangoes and oranges. He observed that when two crops were possible in one year especially in the case of oranges and mangoes, Colombo was always flooded with foreign oranges and other fruits like apples and grapes. During the off season an orange fetched as much as 50 cents in Colombo. He asked whether Mr. Richards had at any time looked into that matter as to why local fruits were not available in the Colombo markets as it used to be some years back. He said that during the time of Mr. Drieberg, Superintendent of School Gardens, fruits were in abundance even in Colombo.

He added that although Mr. Richards had mentioned about home gardens in the course of his talk, today very few people had home gardens with fruit trees.

Mudliyar Wickremaratne also said that although research work was being done in the Department, there was not enough practical work in the villages. He hoped that the Department would do more practical work in the production of fruits in the country.

He remarked that although different varieties of oranges were grown such as Nattandiya oranges, Vavuniya oranges and Bibile oranges, it was at times difficult to find a ripe orange in Colombo. Even a sick man could not get a ripe orange because the cultivators were in the habit of picking them green. He believed that cultivators had got used to picking oranges green during the time of the former Marketing Commissioner, Mr. Basset, who encouraged green oranges for the preparation of fruit cordials. He said that that was a matter for Mr. Richards as Horticultural Officer to go into. He had written several articles on that matter to the "Govikam Sangarawa".

Mudliyar Wickremaratne suggested that the Department should try somehow and introduce a method of obtaining two crops in one year in all fruit varieties. He said that although there were two seasons for lime, a fruit sometimes cost 10 cents.

In conclusion Gate Mudliyar Wickremaratne thanked the Department for the research it had done in fruit cultivation and urged that more practical work should also be undertaken. As regards home gardens, he said that Agricultural Instructors should undertake the work of encouraging fruit trees in home gardens.

Major E. C. de Fonseka inquired whether Mr. Richards had carried out any experiments in regard to colouring of oranges. Major Fonseka said that in time to come if this country was in a position to export oranges, a study of the colouring technique would be very useful. He added that although green oranges were popular in Ceylon, it was not the case abroad.

Mr. Anton C. Ponnampalam inquired how much it would cost to clear the land and grow an acre of orange, inclusive of the expenditure on grafted plants. He also inquired how many years the plants would take to come into full bearing so that a man starting an orchard on a commercial basis would know exactly after how long he would get returns for the capital he had invested.

Mr. W. M. Coomaraswamy inquired whether it was possible besides the two seasons for mangoes and oranges to intensify the production of a further crop by treating the plant.

Mr. S. Sivapalan inquired whether Mr. Richard was aware that the economy of the rural population in villages was reduced comparatively owing to the Jak fruit being attacked by an insect. If so, he wished to know what remedies Mr. Richards would recommend. He added that there was a belief in some villages that the cactus plant was responsible for the disease but he did not know the truth of it.

Regarding bud-grafted sweet orange, Mr. Sivapalan said that there had been much complaint in the past that grafted plants from the Department were not very successful. If research had proved that bud-grafted

plants were the best, he wished to know the particular kind of graft that was recommended.

Regarding a reference made by Mr. Richards to orchard sanitation, Mr. Sivapalan wished to know what was really meant by that term.

Mr. Ashmore Peiris said that Kotte oranges were quite large and had a soft skin which he believed was a good variety to propagate. He inquired whether that variety could not be propagated on a large scale.

Mr. H. Abeygoonesekera inquired about the seedless Bibile orange and about the results of the rejuvenation of the old citrus trees at Bibile citrus farm.

He added that Mr. Richards must be aware of the high incidence of disease in orange plantations in Lower Uva. He said that there had been some kind of demonstration in the area to instruct the agriculturist what he should to fight the disease. He added that he would like to impress on Mr. Richards that more demonstrations were necessary in that area orange had been a crop that gave a fair income to the cultivators in lower Uva and the incidence of disease had reduced their incomes considerably. He suggested that a full week be devoted to instructing the cultivators in that area towards April or May.

Mr. A. M. Clement Dias inquired about the possibility of growing grapes in Ceylon and mentioned that grapes were grown fairly successfully in Jaffna.

Referring to the variety of pears found in Ceylon, he remarked that only cooking pear were found in Ceylon which would have very probably found its way into the Island through a planter who would have wished to try it out in Ceylon.

Mr. Clement Dias also mentioned that certain chemicals, &c., prescribed in some of the leaflets issued by the Department were not easily understood by the ordinary man and also wished that those leaflets be printed in Sinhalese as well.

At this stage the leaflet he was referring to was available in Sinhalese and was handed to him.

Mr. S. L. Bandara Dharmakirti said that he had planted out an acre of land with grafted orange plants all of which died after a short period. He inquired whether the general belief was true that grafted plants were more difficult to grow than those propagated by seedlings.

Mr. K. Kanagaratnam said that the question of fruits in Ceylon was as keen as the question of milk. He added that the growing generation should have plenty of fruits to eat, particularly oranges, mangoes, grapes, &c. He said that Mr. Richards had mentioned that the two varieties of mangoes at Hingurakgoda, Karutha Colomban and Vellai Colomban, were brought from Jaffna, but he wished to add that there were many villages in which mango trees grew wild, the fruit of which was not sweet and that the people did not know to make it sweet. He had some trees in his own garden and some Departmental officers were consulted who had advised him that grafting with a sweet variety would improve the taste of the fruit but so far it had not been possible. He also advocated the belief that mangoes could be grown in the Dry Zone on a commercial scale. Referring to mangoes grown in Jaffna, he said that the same varieties grown elsewhere did not give the same taste.

With regard to the cultivation of grapes, Mr. Kanagaratnam said that in the olden days grapes were grown in the village of Mathagal, but today Catholic Fathers at Tholagatty grew it for preparing wine. He believed that the grapes grown there were not up to the standard. Mr. Kanagaratnam inquired whether anything could be done to resuscitate the industry which existed 30 or 40 years ago.

Mr. Kanagaratnam also suggested that more Experimental Stations should be established in the Island for encouraging the cultivation of oranges since oranges were very scarce in the country. He said that today an orange could not be bought for less than 50 cents. At the present time Ceylon had to depend mostly on imported oranges which reached the consumer after fumigation, &c.

Mr. Kanagaratnam inquired why the Department could not organise Exhibitions at which various varieties of mangoes and oranges would be exhibited. When he was

in Bombay, he had seen over 100 varieties of mangoes being exhibited. He said that competitions for home gardens and exhibitions of that nature would not only be an encouragement to the people but the Department would also be able to collect as many varieties as possible. He believed that that type of encouragement would also help commercial production of fruits. He said he would endorse Mudliyar Wickremaratne's views that experimental work alone was not sufficient but villagers should be encouraged to grow fruit trees through the medium of field officers.

Sir James P. Obeysekera inquired whether any remedy could be suggested for die back for mango and oranges.

Sir James also stated that he would like to relate to the Research Officers his experience of how an orange tree was made to bear right through the year. Right round the tree about twelve holes were dug, about the size of a barley tin, and every morning urine from the stables was poured into those holes, and the tree started bearing all the year round.

Mr. N. H. Keerthiratne related his experience of how 4 acres of oranges planted out with seedlings had all died after a period. He had then tried an inter-cultivation of coconut and oranges and when the coconuts grew up the oranges had died again. At present too he had a plantation of oranges mixed with coconut and there too the oranges were dying. He added that it was therefore difficult for a capitalist to run an orchard by growing only oranges since the trees died after a period.

Chairman : "I will now ask Mr. Richards to answer the questions put to him to the best of his ability."

In answer to Gate Mudliyar Wickremaratne's question, Mr. Richards said that as far back as 1935 the Department was using either the sour orange or the Pummelo stock for grafting purposes. But now it had been found that the sweet orange was a better stock which was more compatible.

In regard to the failure of his mango trees to bear sufficient fruits, Mr. Richards said that it could be due to lack of manuring since the mango tree also requires manuring. He also added that in recent years the mango hopper was found to have done a lot of damage to mango flowers during the flowering season and prevented satisfactory fruit setting.

In answer to Major E. C. de Fonseka, Mr. Richards said that the initial work on fruit colouring in Ceylon had been done by the Chairman on which an article had appeared in *The Tropical Agriculturist.* Since then that work had been carried on by the Chemical Division and the technique is very well known. He added that Ethylene and Acetylene gas were used for the process, but now in America they had found that hormones could be used for ripening of fruits.

Referring to Mr. Anton Ponnampalam's question about the cost of establishing an orchard. Mr. Richards said that unfortunately figures were not available since most of the work was done on an experimental scale with various stock-scion combinations. But he said that at Hingurakgoda where there are about 100 acres under mango, during the year 1949-50, out of an expenditure of Rs. 880 the amount realized by the sale of fruits was 2,102. In the year 1950-51, the value realized from fruits was Rs. 3,903 when the expenditure was Rs. 1,400. In the year 1951-52, the expenditure was Rs. 2,100 while the value realized by sales was Rs. 4,926. In the year 1952-53 a sum of Rs. 3,050 had been spent while the value realized by the sale of fruits was Rs. 7,757. He said that the initial expenditure would be on the clearing of jungle and preparing the land. The cost of a grafted plant was about Rs. 2.50. He said that for the first two years it would be possible to grow some kind of inter-crop to offset the expenditure. After that period it would be difficult to continue an inter-crop as the fruit trees would begin to spread out. He added that in the case of mango at Hingurakgoda, from 40 acres which were in full bearing, it was possible to get a return of Rs. 7,757 when the expenditure was only Rs. 3,000. That land, he said, was also used for grazing purposes. As regards oranges, it was possible to grow it on a commercial

scale only in places like Bibile and Moneragala where the soil was deep and had a rainfall fairly well distributed.

In reply to Mr. W. M. Coomaraswamy's question whether an off-season crop would be obtained by treating the plant, Mr. Richards said that by root exposure followed by heavy applications of cattle manure and flood irrigation in basins during the dry season when the trees were nearly wilting it was possible to induce a new flush to appear and produce flowers but it had a bad effect on the tree which could not live for more than 10 years if the treatment was practised yearly. That method had been tried out at Vavuniya but it was found to shorten the life of the tree.

As regards Mr. Sivapalan's question about the incidence of disease in Jak, Mr. Richards said that it was due to an insect entering the fruit almost at the flower stage and that it could be remedied by dusting gammexane on the young fruits at the early stages.

In answer to Mr. Sivapalan's question whether grafted sweet orange issued from the Department was not very successful, Mr. Richards said that sometime back sour orange and pummelo stock were used for grafting which were not found to be very suitable, but at present the grafts were on sweet orange stocks which were quite compatible and were found to live longer.

Regarding Mr. Sivapalan's question about orchard sanitation, Mr. Richards explained what it meant. He said that trees should be sprayed regularly against diseases and pests, that the orchard should be kept free of weeds and that irrigation should be provided during the dry season. He added that attention should also be paid to manuring.

Replying to Mr. Ashmore Peiris' question, Mr. Richards said that unfortunately not many of the original trees of the Kotte variety of oranges were found today, but however, he was on the look out for a few good trees to propagate that variety. He said that he hoped to multiply that variety if suitable material were available, but at the same time he would like to mention that it was not desirable to have too many varieties. The two varieties he would recommend at the moment were the Vavuniya orange and the Bibile seedless orange.

In answer to Mr. Abeygoonesekera's question, Mr. Richards said that the first seedless Bibile orange was exhibited at one of the Agri-Horticultural Shows conducted by the Department. It was obtained from a tree growing in a village called Etanawatte. A description of it had appeared in an issue of *The Tropical Agriculturist.*

Regarding Mr. Abeygoonesekera's question about rejuvenation of orange plants, Mr. Richards said that if the orange plants were not badly affected by disease it was possible to rejuvenate them by inarching young seedling stock into the main stem. But in the case of trees that were badly affected by disease, rejuvenation by inarching did not help. He said that it was always possible to keep down disease by early spraying with fungicides.

In regard to the extension work in the lower Uva area to which Mr. Abeygoonesekera had made reference, Mr. Richards said that a Citrus Field Day was held by the Divisional Agricultural Officer and that a good deal of work had been done during that period and agreed that more work on orchard sanitation could be demonstrated to the people in that area.

Replying to Mr. A. M. Clement Dias in regard to the cultivation of grapes, Mr. Richards said that in most places in Ceylon the rainfall interfered with the setting of the crop, but in certain favourable localities like Kalpitiya and Jaffna crops could be grown. He added that trials were carried out with certain Indian varieties and that an Australian variety, Ohanez, was also imported for trial which was supposed to be a very productive and sweet variety grown for export. It is trained on overhead trellis like the local variety.

Referring to Mr. Dias' question about pears, Mr. Richards said that the variety at present grown was called stewing pears. He said that certain varieties of dessert pears were under trial but owing to the absence of sufficient winter cold, it was not possible to break the dormant period of the bud thus allowing it to flower. Although the trees produced a few leaves and flowers, they did not fruit satisfactorily.

In reference to Mr. S. L. Bandara Dharmakirti's question, Mr. Richards said that generally budded plants were short lived compared to plants raised from seedlings.

In answer to Mr. Kanagaratnam's question, Mr. Richards said that five varieties of mangoes were grown by the Department, namely, Willard, Karutha Colomban, Vellai Colomban, Ambalavi and Sabre. He agreed with Mr. Kanagaratnam that the mangoes such as *Chembattan* that grew in the red soils of Jaffna had a distinctive flavour of their own, but when grown in Colombo and other places, the flavour was not up to the same standard, and the plants were also susceptible to disease. Similarly he said that Bibile oranges grown elsewhere did not have the same flavour. Referring to home gardens, he said that certain fruit trees were not grown in home gardens due to superstition that such trees were unlucky close to the house. In Jaffna, the Hindus had a belief that grapes were very unlucky to be grown in the home garden. Similarly, people in Kalutara thought that mangosteen was an unlucky tree in the garden.

In reply to Sir James P. Obeysekera, Mr. Richards said that die back in orange which is generally caused by citrus mildew could be overcome by spraying the young plant with sulphinette which was a specific against citrus mildew. Die back in mango was often due to the mango hopper and sooty mould which brought about defoliation followed by die back, which could also be overcome by spraying.

Referring to Mr. Keerthiratne's question about growing coconut and citrus, Mr. Richards said that it was not a desirable combination especially in the case of coconut since the root system extended so widely that it would naturally retard the growth of the citrus. He said he knew of an orange garden interplanted with coconut in Middeniya which died off in five years. He said there was another orchard in the Colombo area which was a failure as the land consisted of hard laterite. He explained that before one ventured on a large scale it was always necessary to ascertain whether the land was suitable for the crop.

Chairman—"There have been several questions which have been answered by Mr. Richards as best he could. I think you will all wish that I should express to him, on behalf of the Board, our sincere thanks for the very informative talk he has given and the replies to questions raised.

Mr. J. M. Sabaratnam inquired whether it is possible for the Department to bring out a leaflet suggesting the various areas that were suitable for different varieties of fruits so that the people would know exactly what to grow in their villages. He also suggested that more propaganda should be conducted with a view to encouraging fruit cultivation.

Mr. Sabaratnam also inquired whether it was not possible to establish more fruit supply nurseries so that people in places like Mannar and Vavuniya need not have to buy their plants all the way from Peradeniya.

Mr. Richards replied that some of the leaflets that were being put out would contain such information as referred to by Mr. Sabaratnam, and that leaflets were being issued for each variety of fruits.

Referring to Mr. Sabaratnam's second question, Mr. Richards said that mango grafts were supplied from Jaffna and that citrus were supplied from Vavuniya and also from the nursery at Bibile. He said that there was a large mango nursery at the Jaffna Farm School for issue of plants and that a good deal of planting material was raised in Bibile itself. He added that it was the experience of the Department that plants distributed free were not sufficiently well looked after unlike in the case of plants which were paid for.

Mr. A. M. Clement Dias said that he had observed a number of diseased plants in several pineapple plantations and inquired whether the Department was taking action to see that diseased plants were eradicated from estates and wondered whether there were any Government Regulations or by-laws to that effect. He also suggested that if the Department could contact the Marketing Department and obtain a list of pineapple estates from which the Marketing Department obtained their supplies, good pine suckers could be obtained.

Mr. Richards said that the Department had contacted the Marketing Department and all the crowns of pineapple sent for canning, which were supposed to be the best fruits from disease free plants, were obtained for raising suckers.

Gate Mudliyar Arthur D. S. Jayasinghe remarked that he had applied to the Department for a few Sapodilla grafts but he was informed that Sapodilla grafts were not available.

Mr. Richards said that Sapodilla was grafted with Palu stock and that Palu took at least two years for budding and that was why there had been a delay in supplying Sapodilla grafts. He added that Sapodilla grafts could now be made available.

IV. Discussion on Cacao in Ceylon

A model propagator was shown to the audience by Mr. Richards, Horticultural Officer, who explained how cacao could be propagated by cuttings. He showed two specimens of rooted leaf cuttings and stem cuttings. He showed that the leaf cutting consisted of only a single leaf while in the stem cutting there were three or four leaves. He said that the cloth propagator was easy to construct and inexpensive and demonstrated how the rooted cuttings could be potted in supply baskets and planted out after they had hardened in a moist chamber.

Mr. Richards—"Cacao was first introduced into Ceylon by the Dutch in 1819 but was developed commercially as a plantation crop by the British from 1878 when the first export of 10 cwt. of cured cacao was recorded. Since then the demand for this commodity has shown considerable increase, and no less than 58,050 cwts. of cured cacao valued at Rs. 10,584,265/00 were exported last year, and of this 15,547 cwts. were shipped to the Philippines and 15,453 cwts. to Japan, the United Kingdom taking only 5,706 cwt. There has been further increase in the planting of cacao particularly under rubber in recent years and it is estimated that over 30,000 acres are presently under this crop, about 55 per cent. in the Kandy District and 33 per cent. in Matale District. The prevailing high prices which average Rs. 168 per cwt. are an incentive to further planting.

Cacao grown in Ceylon in the early years was predominantly of the Criollo type but owing to admixture of the more dominant Forastero types introduced later it now consists almost entirely of a complex mixture of Criollo and Forastero which is not unlike the Trinitorio cacao of Trinidad and Indonesia. The true Criollo beans are quite plump, white when cut and produce a cinnamon coloured product when cured; the Forastero types including the West African Amelanado have small flattish beans, dark purple in colour and chocolate brown when cured. The Trinitorio beans are fairly plump, purple in colour and red-brown when cured. Both Criollo and Trinitorio types produce the so-called 'fine' or 'flavour' cacao of commerce which constitutes 5 to 10 per cent. of the world supply, while the Forastero types produce the ordinary cacao which forms the bulk of the world supply. The demand for 'fine' cacao is limited and the premium it commands is not high enough to justify the sacrifices of yield for quality in the selection of suitable clones. Consequently the aim is to establish only high yielding clones which come into bearing early and produce cacao of reasonably good quality acceptable to the trade. In the absence of proved high yielding clones in Ceylon a programme of selection was initiated at Kundasale and other cacao growing areas with the approval of the Cacao Research Committee at the commencement of the main cropping season in October last year and steps were also taken to introduce high yielding clones from Trinidad, New Guinea and West Africa after a satisfactory period of quarantine at Kew Gardens.

The following selected clones imported by air from Kew as rooted cuttings have been successfully grown under quarantine at Batalagoda and established in the field at Kundasale and Ambatenne, Katugastota. for trial:—ICS 1, 8, 39, 45, 60, NA 32 and PA 35. Recent successful introductions from Kew which are still under quarantine at Heneratgoda are ICS 1, 6, 40, 84, 89 and 98. These include two plants of Herrania species which being closely related to cacao are used in hybridisation work.

Introductions from the Keravat Cacao Research Station, New Guinea, consist of eight selections raised from seed. According to Urquhart and Dwyer who in 1951 reported on the growing of cacao in Papua and New Guinea, these selections yield from 15 to 18 lb. of cacao per tree per annum, which are exceptionally high yields compared to the average yield in Ceylon of about a pound of cacao per tree per annum.

The West African Amelanado was introduced from Malaya through the courtesy of the Director of Agriculture, Malaya, who sent two ripe pods by air for seed extraction. Several plants were grown under quarantine at Heneratgoda and planted out in the field at Kundasale and Ambatenne, Katugastota. This variety breeds true and produces small pods in large numbers, and each pod containing numerous small flattish beans which when cured produce the ordinary cacao of commerce.

In Trinidad where selection work has been carried out since 1932 under the Cacao Research Scheme the objectives are to select healthy mother trees which under estate conditions produce at least one ton of cured cacao per acre and which show a pod value of 7½ or less, the pod value being the number of pods required to produce one pound of cured cacao assuming 60 per cent. loss of weight in curing.

In West Africa where the Amazonian Forastero or Amelanado cacao which is grown extensively produces small flat beans, greater emphasis is placed on total yield per acre than on the pod value which is calculated on 53 per cent. loss of weight.

In Ceylon the loss of weight on fermentation and curing is slightly greater owing to the prevailing practice of washing the beans after fermentation in the sweat boxes and has been found to average 63 per cent. With about 190 trees to the acre at a spacing of 15′ × 15′ the yield should average 12 lb. of cured cacao per tree in order to produce one ton per acre. A tree with a pod value of 7 should produce a minimum of 84 pods while one with a pod value of 5 need only produce 60 pods to yield 12 lb. of cured cacao. Assuming 63 per cent. loss of weight on curing the wet weight of beans per pod works out to about 5.4 ozs. for a pod value of 8 and 8.6 ozs. for a pod value of 5. On this basis only trees yielding over 60 pods each per year and over 5½ ozs. of wet cacao per pod are considered for selections.

A preliminary tree to tree survey was carried out at the commencement of the main cropping season in August, 1952, and about 130 trees were selected for study of performance after taking into account the age of the individual tree, its location, canopy space, number of pods, size of pods, wet weight of beans, size and number of beans and freedom from diseases, &c. Yield records and pod values were then recorded and at the end of the two cropping seasons twenty-five of the most promising trees were tentatively selected for further study and the others rejected. This year about 82 trees have been tentatively selected and of these the most promising ones have pod values ranging from 6.4 to 8.6 and the number of pods produced in September and October, 1953, already exceed 60 each. Their performance will have to be studied for a period of at least five years before a final selection is made, meanwhile action has been taken to raise rooted cuttings and budgrafts from the individual parent trees for study of the performance of the clonal progeny.

Vegetative Propagation

As Trinitario cacao does not normally breed true to type from seed selected parent trees have to be propagated vegetatively from cuttings or budgrafts.

Cuttings are of two types, leaf cuttings which consist of a single leaf and stem cuttings with three or four leaves. They are rooted in a special type of cloth covered propagator which is easy to construct, inexpensive, but efficient. The rooting medium consists of unsieved mixture of coir dust and fibre, and water is allowed to drip on a row of bricks and splash on to the leaves, covering them all the time with a thin film of moisture. Atmospheric humidity within the propagator should be maintained at high level and the temperature should not be allowed to go above 30° C. But the cuttings should receive plenty of light and the rooting medium should not

become water logged. Under favourable conditions over 95 per cent. of the cuttings strike root within four to five weeks. They are then potted in supply baskets and hardened in a moist chamber before planting out. Cuttings from the trees at Kundasale many of which are affected by virus and sickle leaf disease do not strike root so readily as disease-free material from Peradeniya, the average being 25 and 85 per cent. respectively. Rooted leaf cuttings require special attention when planted in vacancies in the field. In a trial with 50 rooted leaf cuttings and 50 seedlings planted in vacancies in an old cacao field in May, 1952, only 30 per cent. of cuttings survived in spite of hand watering during the drought as against 54 per cent. of seedlings which were not hand watered. Stem cuttings produce more vigorous plants and are probably easier to establish in the field.

Budgrafting is easy on cacao, and if buds are taken from chupon growth an erect growing vigorous plant with a desirable habit of growth is produced. This method of propagation is practised in Indonesia in preference to root cuttings since the latter produces plants with undesirable low branching habit of growth which interfere with cultural and harvesting operations.

Pollen Compatibility

Cacao flowers generally open at night and pollination is effected by insects, mostly night flying midges, but small ants and aphids are also known to act as pollinating agents. Adequate pollination is necessary for satisfactory setting of pods and hence in any programme of spraying against insect pests such as Helopeltis an important consideration is the risk of destroying beneficial insects which pollinate flowers, or parasites, or eat up virus transmitting mealy bugs. This aspect of the problem will be discussed by the Entomologist. In some cacao trees which are known to be self compatible pollination and fertilization are effected by own pollen, while in others which are self-incompatible satisfactory cross pollination is necessary for setting of pods. Two self compatible trees are always cross compatible, but two self incompatible trees are cross incompatible. A self compatible tree will set fruit with own pollen, or pollen from another self compatible tree or self incompatible tree, but the latter will set fruit only with pollen from another self compatible tree. It is therefore a distinct advantage to select high yielding clones which are self compatible since not only do they set fruit readily with own pollen but also induce fruit setting in other self incompatible as well as self compatible trees. In view of the ease of pollination self compatible trees generally carry a good crop of pods. Of the potential mother trees selected tentatively at Kundasale six have been found to be self incompatible and all of them have given over 125 pods each last season as shown in the following table :—

Tree No.	*Yield of Pods*	
	August, 1952, to July, 1953	*August, 1953, to October, 1953*
34	152	35
35	126	40
36	173	44
46	131	125
101	239	285

Fertilizer Trial

A fertilizer trial has been set down in collaboration with the Chemist to study the effect of the following treatments :—

1. Control—no fertilizer
2. P. Superphosphate and Saposphosphate at 1 lb. per tree.
3. K. Muriate of Potash at 10½ oz. per tree.
4. P. K. Super, Saphos and Muriate at 26½ oz. per tree.
5. N. P. K. Sulphate of Ammonia .. 8 oz.
   Super & Saphos .. 16 oz.
   Muriate of potash .. 10½ oz.
   .. 34½ oz. per tree

There are five randomized blocks with five plots in each block for the five treatments and from 35 to 40 trees in each plot of which only 15 trees selected at random are recorded for yield of pods and wet weight of beans.

The trial has been in progress only for one season.

Fermentation Studies

Cacao is normally fermented in large sweat boxes 9′ 6″ long, 6′ broad and 3″ high but attempts at fermenting small samples in miniature boxes 2′ × 1′ × 1′ high were a failure since the fermentation process was not sufficiently intense and the rise in temperature to 33° C as against 45° C in the large boxes was not high enough to kill the embryos. None of the beans from the small boxes were viable even after 36 hours.

V. Cacao Diseases

Dr. J. W. L. Pieris (Plant Pathologist)—"Mr. Chairman and Gentlemen, I am glad to have the opportunity of presenting my aspect of the subject. In recent years the diseases of Cacao have assumed considerable importance throughout the world. In Ceylon too during the last four years more and more attention came to be given to this aspect of cacao cultivation.

Prior to 1949, the diseases which were mainly associated with this crop in Ceylon were—

1. Stem canker and pod rot of cacao caused by the fungus *Phytopthora palmivora* which is incidentally the same fungus which causes many diseases of rubber. The control of these diseases consists in field sanitation and early detection and treatment of affected trees with a disinfectant. After scraping off the diseased areas, diseased pods should be also continually eliminated from the plantation as they may be a source of further infection. With the present high prices of cacao, spraying of pods with fungicides may prove uneconomical and this aspect is receiving our consideration.

2. Dieback of twigs and branches which was generally thought to be due to unfavourable water relations.

3. Sudden death or "Subito morte" as it is referred to in certain countries. The cause of this disease still remains obscure among plant pathologists and no definite casual organism could be considerably associated with this condition. In Ceylon however we have found some of the trees showing sudden death to be ringed by canker. In Malaya a fungus *Ganoderma pseudoferreum* causes a similar condition.

A few years ago the report of a serious virus disease of cacao in the Gold Coast caused grave concern in cacao circles. Trees were reported to be dying there by the million and between the years 1945 to 1948 the losses were fifteen million a year. Posnette working in the Gold Coast demonstrated that the cause was a virus which he originally designated the "swollen shoot" disease of cacao. Unlike those diseases caused by fungi, bacteria, eelworm, &c., in which the causal organisms could be observed with the naked eye or by use of the microscope, virus diseases are not characterised by any visible parasitic

organism in the diseased tissues. The disease is caused by an infective principle which is invisible but is nevertheless there and produces certain visible symptoms on the plant. In the case of the swollen shoot virus, the leaves of affected trees showed well marked patterns like watermarks and there were swellings on stems, rounding of pods, &c. Certain species of mealy bugs have been shown to be able to transmit the disease from diseased to healthy plants. It has subsequently been shown that there are a number of strains of cacao viruses, some of them more virulent than the others.

In 1943 symptoms resembling swollen shoot virus disease were first reported in Trinidad cacao in plants varying in age from five to fifteen years. These symptoms were however not identical with the virulent strains of swollen shoot in the Gold Coast in that they do not cause swellings and also were not so virulent. They resembled some of the milder strains occurring in the Gold Coast.

The scare caused by the Gold Coast disease induced us to look closely into our own cacao. In 1949 symptoms on leaves analogus to those recorded by Gold Coast workers first came under the observation of the Division of Plant Pathology. The symptoms were present on a considerable number of trees although most of them had only very few affected leaves. Some of the most healthy and vigorous plants often show at least a few leaves bearing the virus symptom and our general observations so far incline us to the view that our strain of the cacao virus is one of the less virulent ones recorded in the Gold Coast and Trinidad. As it is possible that our original cacao came from the West Indies as living plants the virus too could have come from Trinidad at that time.

An examination of the cacao estates showed that beginning with Kundasale and Pallekelly as centre virus symptoms have been observed up to 14 miles towards Matale and about 9 miles towards Kurunegala. It may therefore be assumed that this virus is generally present in most of our older plantations. New plantations however have so far shown no incidence of the virus.

The virus nature of this disease has been established by graft transmissions. Nine out of ten grafts made with disease buds on healthy stock showed transmission of the disease to the healthy stock. The division of Entomology has demonstrated that two species of mealy bugs are capable of transmitting the disease.

Dadap trees growing as top shade for cacao were also simultaneously observed to show symptoms of vein clearing and is suspected to be an alternate host for the cocoa virus. Scientific proof of this is still being sought.

The present position is therefore that we are aware of the presence of a virus disease in our cacao and as far as our present observations go it is not one of the virulent strains as the presence of the swollen shoot virus itself would have postulated a much higher mortality in our cacao. Nevertheless we cannot be positive that its presence is absolutely innocuous. It may cause a certain amount of depression in yields. Observations over a number of years are necessary to elucidate this point and to find out the rate of spread of the disease.

We are on the lookout for any other virus strains that may exist and there also remains the possibility of mild strains mutating into more virulent strains so that constant vigilance is required. I might also mention the fact that it is generally held that the presence of a mild strain of virus in a plant can immunise it against the entry of another strain. If this is so we might consider the existence of the present virus strain in our cocoa as the silver lining in the cloud.

Sickle Leaf Disease

About the same time as the observation of the virus disease of cacao, another diseased condition of cacao at Kundasale same under our notice causing more damage than the virus disease. Affected trees were stunted and unhealthy, there was a considerable amount of dieback of branches and the most characteristic symptom was the chlorosis of the leaves which were narrowed and twisted

in the form of a sickle. Hence the term Sickle leaf. The disease was observed both on adult trees as well as seedlings.

In the investigation on this disease transference of affected seedlings into fresh soils and watering with nutrient solutions brought about improvement. Foliar sprays with zinc solution on adult plants also produced considerable improvement. Spectroscopic analysis of diseased leaves showed a low zinc and copper status in them as compared with healthy leaves. No parasitic organism appears to be connected with this disease and it appears to be caused by the deficiency of certain nutrients to the plant.

The Chemist has recently noted improvement in plants treated with dolomitic limestone. Further investigations are however necessary before the actual factors predisposing to this condition are known with certainity.

VI. Pests in Cacao

Dr. H. E. Fernando (Entomologist)—"Mr. Chairman and Gentlemen, Dr. Pieris has helped me considerably in discussing one of our major problems, the various diseases of cacao, so that I can cut short as much as possible.

The cacao plant in Ceylon is susceptible to attack by a number of insect pests some of which cause direct injury to the plant while others act as vectors of a virus disease of cacao and introduce the disease into the cacao plant when feeding on the plant.

Insect pests of cacao range from stem pod and bark boring caterpillars, through thrips which feed by rasping the leaf or pod surface into plant sucking bugs like Helopeltis, aphids, and mealy bugs which feed by sucking the juices of the plant.

The majority of the insects infesting cacao plants are incidental and cause no serious damage to the cacao plant. However, a few cacao insects are responsible for major losses of the crop either indirectly or directly. They may be represented as follows in order of their importance :—(1) Helopelitis, (2) Mealy bugs, (3) Thrips, (4) Pod, stem and bark borers.

The pod borer *Dinocrocis punctiferalis* is a caterpillar which bores into the pod and feeds only on the fruit wall leaving the beans intact. The chief danger of this damage, however, is the providing of openings for the entry of fungi and bacteria which cause rotting of the pod.

The bark borer of cacao *Indarbela quadrinota* is a caterpillar which feeds on the bark and protects its feeding tract by a gallery of frass and causes its main damage by tunnelling into the wood for a shelter during the day. This tunnel provides entry for bacteria and fungi which can cause rotting of the stem.

The stem and root borer of cacao, *Zeuzera coffeae* is again a caterpillar which bores into the branches and the roots of cacao plants. Young cacao plants can be killed by an attack of this pest.

Cacao thrips represented by two species, Helopelitis and Selenothrips, are responsible particularly for damage of young flush of cacao plants. They feed on the young leaves by rasping the leaf surface and sucking the juices that exude. The result of such feeding is the drying of sections of the young leaves.

Three species of mealy bugs attack cacao in Ceylon. They are *Pseudococcus Lilacenous, P. Citri* and *P. Vigratus.* These bugs feed by sucking the juices from the pods or stems of cacao plants. Two of the species of mealy bugs *P. Lilacenous* and *P. citri* are responsible for spreading the oak leaf virus disease of cacao. In feeding on a diseased plant the mealy bugs become infective. Young crawlers of mealy bugs are carried from tree to tree by ants or by wind. If a healthy plant becomes infested by infective mealy bugs the oak leaf disease is transmitted to the healthy plants. The dadap plant which is used as a cover crop on cacao estates shows symptoms of a virus disease similar to the oak leaf disease on cacao. Studies are being conducted to establish the relationship between the disease on cacao and on dadap. If this is positively proved, serious consideration will have to be given to abolishing dadap as a cover on cacao plantations, especially by vegetative propagation. Studies on the control of mealy bugs on cacao and thereby the control of the oak

leaf virus are following two main lines:—(1) insecticidal control by controlling ants which carry mealy bugs from tree to tree, (2) biological control by the introduction of parasites. Before introducing parasites from foreign sources a study is being conducted to evaluate the local parasites of cacao mealy bugs.

Helopelitis, a plant sucking bug, is responsible for the most obvious and extensive damage of cacao plants in Ceylon today. In feeding this bug sticks its probosus into the plant tissue and injects a small quantity of saliva. The salivary secretion of this bug has a toxic effect on the plant tissues which gets discoloured and perishes in circular spots surrounding the feeding puncture.

Helopelitis feeds on growing shoots, leaves and pods of the cacao plants, and whenever feeding has occurred marked spotting is apparent. Feeding on young shoots by Helopelitis causes die back in the plant while young pods which are attacked shrivel up and rot. Older pods when attacked are extensively spotted, retarded in growth and it is difficult to say when the pod is ripe. Insecticidal trials have been conducted to control Helopelitis. Monthly low volume sprayings with D.D.T. or Dieldrin have given good control of this pest. A cheaper method of control of this pest is to be tried out on a large scale with benzene hexachloride dusts."

Chairman—" We have had three officers to address us on various lines of work conducted by the Department. I am sure there are some of you gentlemen who are interested in the growing of cacao, and I trust that these talks have been of value and interest to you. You will also agree that I should thank these officers on behalf of the Board for their valuable contributions to the subjects discussed today."

Major E. C. de Fonseka said that he was not a cacao planter but he would like to ask two questions from Dr. Pieris. He inquired whether the two diseases of cacao prevalent in the Gold Coast known as Swollen Stem and Swollen Shoot were the same. He also inquired whether the disease called Witch Broom which was found in the Gold Coast was present in Ceylon too.

Dr. J. W. L. Pieris answered that Swollen Shoot and Swollen Stem were names given to one and the same disease.

Regarding Major Fonseka's second question, Dr. Pieris said that Witch Broom was caused by the fungus Marasmius Pernicosus and that it had not so far been recorded in Ceylon.

Gate Mudliyar N. Wickremaratne said that he was very pleased to learn that such a lot of work had been done by the young experts of the Department without it having to depend on the so called experts from abroad.

He said that 48 years' ago he had come to the School of Agriculture, the very place where the present meeting was held, to study agriculture. For a number of months his study had been devoted to village crops. During that time he remembered Mr. Petch who went into the study of the fungus in cacao, which was prevalent in large areas of cacao. Mudliyar Wickremaratne had been entrusted with the job of finding out whether cacao could be introduced as a village crop. At that time when cacao was selling at Rs. 30 per cwt. people in the villages took up to its cultivation and he saw no reason why they should not cultivate it now in the villages when cacoa fetched about Rs. 168 per cwt. He inquired whether Mr. Richards could do something to encourage villagers to take up to cacao cultivation.

Gate Mudliyar Wickremaratne also inquired whether vanilla could be grown along with dadap in cacao estates. He had seen some vanilla trained on dadap in a cacao plantation towards Galagedera but he had observed that about 50 per cent. of the pods went bad owing to attack by a fungus.

Mr. Richards replied that vanilla could be trained on dadap and other shade trees planted in cacao estates. He added that apart from vanilla, even pepper could be grown. With regard to kapok, he said, it was not advisable to plant it as a shade tree in view of the fact that it is reported to be a host plant for the Swollen Shoot virus in West Africa, and moreover he said that kapok was a tree that shed its leaves during the

drought thus depriving the shade for the cacao when the maximum amount of shade was required.

Referring to Gate Mudliyar Wickremaratne's suggestion that cacao should be grown in villages, Mr. Richards said that there was no reason why it should not be possible since over 60 per cent. of the cacao grown in Trinidad and Gold Coast were from small holdings. He said that the Department was hoping to raise planting material of good quality to introduce it to small holdings and village gardens.

Mr. Victor Ratnayake, M.P., inquired about the branching habit of cacao when it was propagated by cuttings. He said he would like to know which type of cutting—whether the fan branch cutting or the chupon branch cutting—was more desirable for a healthy and erect tree.

Mr. Ratnayake also inquired whether cacao can be successfully grown in areas where rubber had failed due to disease.

In conclusion Mr. Ratnayake complimented the Department for having embarked on cacao trials and he hoped that with all the research the Department was conducting the cacao industry would be placed on a better standard of export.

Mr. Richards explained that plants raised from fan branches, in a majority of the trials conducted, were found to have a low branching habit. He said that low branching interfered with cultural and manurial operations. But, however, buds from chupon branches were found to produce a healthy, erect growing tree, with a more desirable branching habit. In Java they used such buds from budded seedling stock in situ in the field.

Referring to Mr. Ratnayake's question about the possibility of growing cacao in areas where rubber had failed, Mr. Richards said that cacao could be grown in marginal areas where rubber had failed provided there was not too much shade.

Rambukwella Dissawa inquired about the optimum rainfall conditions necessary for growing cacao.

Mr. Richards replied that semi-dry areas with a moderate rainfall was quite good for cacao, but if the rainfall was too heavy the incidence of phytopthora was fairly high. The dry zone proper was unsuitable for cacao.

Dr. H. E. Young, Director of the Rubber Research Institute, inquired whether the Department had taken any action to import phytopthora-resistant cacao clones from abroad.

Mr. Richards replied that Lafi 7 was a phytopthora-resistant clone which the Department was trying to get from Western Samoa. He said that it could not be imported direct but had to be introduced through Kew after a satisfactory period of quarantine. Information had been received that the planting material sent from Western Samoa to Kew had not arrived in good condition for propagation. They were hoping to get more material, and would be glad to send rooted cuttings for trial to the Department once they were successfully raised. He said that he hoped to raise sufficient planting material from the next batch.

Sir James P. Obeysekera inquired whether Mr. Richards could say how hormones were applied and in what strength.

Mr. Richards replied that Alpha Napthalene Acetic acid was used in a mixture with B indole butyric acid at a total concentration of 8 mili grams in one litre of 50 per cent. alcohol and that that method was called the quick dip method. It could also be used alone. The other method he said was by the use of Hortomone A obtainable from the Imperial Chemical Industries. In the latter method the cuttings were left over for a longer period in the solution. Mr. Richards added that with the present improved technique of using the Propagator, which was shown, the results were found to be equally good or even better than with the use of hormones.

Mr. Richards added that cuttings should be taken from healthy trees which were well nourished. Cuttings taken from Kundasale gave only 25 per cent. success due to the sickle leaf disease which was caused by nutritional disorders. But cuttings taken from Peradeniya and rooted in the propagator at Kundasale gave about 96 per cent. success.

Mr. S. L. Bandara Dharmakirti said that in the Matale District villagers were in the habit of rejuvenating the cacao by digging a pit 4 feet by 1 foot round the tree and manuring it with cattle manure. He inquired whether it was necessary in the case of cacao.

Mr. S. L. Bandara Dharmakirti also suggested that it was very necessary for officers of the Department to visit some of the cacao small holdings and give them all possible advice because he had found cacao trees in villages growing to immense heights.

Mr. Richards agreed that the method of manuring cacao practised in the Matale District was quite good and that even in the Wariyapola area the same method was used with pig manure.

Mr. Keerthiratne inquired whether interplanting of rubber and cacao was good, and whether cacao could be planted under coconut.

Mr. Richards replied that Mr. Urquhart had visited some plantations in New Guinea where cacao was grown under coconut, but the cacao was liable to damage by fronds of the palm falling on the trees.

Mr. Richards said that attempts were made to grow cacao under rubber in New Guinea and the British Cameroons but according to Urquhart they were not a success. He said that Mr. Aitkenson was the pioneer in Ceylon who planted cacao under rubber at Keppitigala Estate, but the success of it depended on the growth habit of the rubber clone and the area in which it is grown. If the clonal rubber provided heavy shade, cacao will not grow satisfactorily. He said that towards Matale, Galagedera and Moneragala, the growth of cacao under rubber had been quite promising.

Chairman—"I think those of you who were here at the last meeting of the previous Board of Agriculture would remember that the question of the production and marketing of vegetables was taken up then. A Committee was appointed to go into the matter and their report has been circulated for the benefit of members, particularly of those who were not on the previous Board. The report is of much interest and value, but it was only a preliminary report because it had to be undertaken at comparatively short notice. Mr. Sivapalam was the Chairman of the Committee to whom we are grateful for the report. I would now suggest, if you agree with me, that this very Committee which has been appointed may be commissioned for the further examination of this subject. I would suggest that the same gentlemen be requested once more to reconsider this report as well as the discussions of the Board on it. The record of the discussion appeared in the minutes of the Central Board meeting held on January 21, 1952. Those members of the Committee who will serve on the Committee will be given a copy of these minutes so that they may exactly know the views of members at that time. There are two main points, as far as I can remember, that were brought forward: one was that there should be a guaranteed price for vegetables and the other was the question of marketing which was not considered owing to lack of time. You may add one or two other names if you like to the old Committee, who would then consider the subject over again and submit their report."

Gate Mudliyar N. Wickremaratne suggested that the Committee should reconsider the proposals and offer their recommendations in the report as to what should be done.

Mr. A. W. R. Perera (representing the Marketing Commissioner) suggested that a representative each from the Marketing Department and the Food Production Department should be in the Committee.

Mr. A. M. Clement Dias suggested that Mr. Ellepola should be appointed a member of the Committee since he had made some very useful suggestions at the previous sittings.

Gate Mudliyar Wickremaratne said that although Mr. Ellepola was not the Director, Rural Development, at present, he was doing a good deal of social service work in the country.

Chairman—"I can invite Mr. Ellepola to help the Committee as he was a member of the previous Committee, but I cannot appoint him a member to it."

The Chairman also suggested that since Mr. Sivapalan was the Chairman of the last Committee he should continue as Chairman

of the present Committee. The Board agreed to the Chairman's proposal and Mr. Sivapalan consented to be Chairman of the proposed Committee.

At this stage the Chairman referred to Gate Mudliyar Wickramaratne's memorandum dated November 17, 1953, and said that it was not possible to discuss the memorandum owing to lack of time. He however, promised Gate Mudliyar Wickremaratne that the points he had raised in the memorandum would be sent to various officers for their comments and he hoped to give him the replies at the next meeting of the Board.

Gate Mudliyar Wickremaratne agreed to the suggestion.

Mr. W. M. Coomaraswamy inquired whether the activities of the Milk Board that was proposed to be established would be confined only to the Colombo District. He added that there were a few Co-operatives which were already rendering useful service in that direction and that he would like to know the future of such Societies.

The Chairman said that he was sorry he could not tell precisely the functions of the Board since an Act was being drawn up.

Several members at this stage raised the question whether it was not customary to supply all members of the Central Board of Agriculture with copies of *The Tropical Agriculturist.*

The Chairman said that copies of *The Tropical Agriculturist* were usually issued to all members and that he would look into the matter.

Mr. R. T. Chelliah inquired whether any action had been taken about a previous resolution that was passed at the Board that members of the Central Board should take part in District Agricultural Committee meetings.

The Chairman requested him to bring it up at the next meeting and said that members of the Central Board could attend District Agricultural Committee meetings as visitors. He said he would, however, bring it to the notice of the Permanent Secretary.

Mr. N. H. Keerthiratne requested that copies of the *Govikam Sangarawa* and leaflets issued by the Department be sent to the Rural Development Society, Community Centres, Co-operative Societies, &c.

The Agricultural Officer (Propaganda) said that copies of the *Govikam Sangarawa* were normally issued free.

The Chairman said that the publication of those periodicals cost the Department some money and felt that it would be more desirable if people and institutions who were interested could write to the Department for copies.

Gate Mudliyar Wickremaratne said that from experience he had observed that one and the same person was a member of the Rural Development Society, Co-operative Society, Youth Club and the Agricultural Society, so that it would be more desirable to send copies only to those who would apply for them.

Mr. Anton Ponnampalam pointed out that Government was charging a special tax for Diesoline used for tractors which was very unfair by the cultivators who were using such tractors for agricultural purposes. He added that originally the tax was meant for commercial diesel vehicles which were used on the roads.

The Chairman suggested that it might be brought up as a formal resolution at the next meeting of the Board, or that Mr. Ponnampalam should represent matters to the Director of Food Production, who was empowered to bring such to the notice of the Permanent Secretary.

Mr. Ponnampalam replied that the usual delay in correspondence could be eliminated if the Chairman himself wrote to the Director of Food Production.

Chairman—"Can't this be brought up before the District Agricultural Committee?"

Mr. Ponnampalam—"Sir, I brought it up at the District Agricultural Committee and I was told that as this is a bigger Committee it should be brought up at the Central Board meeting."—(Laughter).

Muhandiram Armstrong—"This is a matter of Government policy. Apart from that, Government has no objection to using

diesel tractors on paddy fields, but if the agriculturists do want to take them to the road and transport various things, they got to pay for it as otherwise it would be unjustifiable for other people who use diesel lorries and who are made to pay."

Mr. Ponnampalam—"I think that gentleman must be owning some diesel lorries, that is why he is so worried." (Laughter.) "The only exception made is for tractors with caterpillar wheels. Tractors with caterpillar wheels are exempted from this tax."

Chairman—"Mr. Ponnampalam can write to me as Director of Agriculture and I will take it up with the Permanent Secretary, but not as Chairman of the Board."

Mr. W. M. Coomaraswamy—"Cannot we pass a formal resolution ?"

Mr. Keerthiratne—"I don't think we should pass resolutions at random on matters concerning Government policy."

Chairman—"Before we disperse I would like to thank Mr. Illangakoon, Principal of the School of Agriculture, on behalf of the Board, for allowing us the use of this hall and for attending to the arrangements for the meeting."

Regarding the date of the next meeting, the Chairman promised to fix up a date somewhere towards the middle of March and to inform members.

The meeting terminated at 5.30 p.m.

A. J. JOSEPH,
Secretary,
Central Board of Agriculture.

The Paddy Lands Act, No. 1 of 1953

(Extract from the *Ceylon Government Gazette*)

L. D.—B 31/53.

REGULATIONS made by the Minister of Agriculture and Food under section 16 of the Paddy Lands Act, No. 1 of 1953, and approved by the Senate and the House of Representatives.

J. R. JAYAWARDENA,
Minister of Agriculture and Food.

Colombo, November 27, 1953.

Regulations

1. (1) These regulations may be cited as the Paddy Lands (Batticaloa and Hambantota) Regulations, 1953.

(2) These regulations shall apply to and in relation to all controlled paddy lands in the revenue districts of Batticaloa and Hambantota.

2. (1) The landlord's share of paddy for any year in respect of a controlled paddy land shall—

(*a*) where that land is cultivated only during one season of the year, be one quarter of the total yield of paddy from that land for that year, or ten bushels of paddy per acre of the cultivated area of that land, whichever is less ; and

(*b*) where that land is cultivated during two seasons of the year, be one quarter of the total yield of paddy from that land for that year, or twenty bushels of paddy per acre of the cultivated area of that land, whichever is less.

(2) Where a lease of a controlled paddy land requires the rent to be paid in money, the rate at which the monetary value of the

landlord's share of paddy in respect of that land shall be calculated shall be the price fixed for the time being for paddy of the same description as the paddy from that land by notification published in the *Gazette* by the Commissioner of Food Supplies for the purposes of the Guaranteed Paddy Price Scheme.

3. (1) The date on or before which a return under sub-section (1) of section 8 of the Act shall be furnished in each year by the owner or lessee of a controlled paddy land to the proper authority shall be the first day of January of that year.

(2) Every return under sub-section (1) of section 8 of the Act shall be in the form set out in Part I of the Schedule hereto.

(3) Every return under sub-section (2) of section 8 of the Act shall be in the form set out in Part II of the Schedule hereto.

4. The register of controlled paddy lands required to be kept by the proper authority under section 9 of the Act shall be substantially in the form set out in Part III of the Schedule hereto.

5. In these regulations—

"Act" means the Paddy Lands Act, No. 1 of 1953;

"Controlled paddy land" and "proper authority" shall have the meanings respectively assigned to them in the Act.

Reference No. ——.

SCHEDULE

PART I

The Paddy Lands Act, No. 1 of 1953

Return under Section 8 (1)

For the cultivation year, January 1, 19— to December 31, 19—

1. Name of paddy land : ————.
2. (*a*) Situation :

   Village/kandam/tract or block : ————.
   Village Headman's Division : ————.
   D. R. O's Division : ————.

   (*b*) Name of tank or Irrigation Scheme under which the land is cultivated (If rain-fed, so state) :————
   (*c*) Vel or Kama Vidane's Division : ————.

		Acres	*Roods*	*Perches*
3.	Extent	————	————	————

4. (*a*) Boundaries : ————.
   (*b*) Reference to plan, lot specifictaion, if any :————.
5. Name and address of owner : ————.
6. (*a*) Name and address of lessee : ————.
   (*b*) Name and address of cultivator or tenant under an ande-tenancy : ————.
7. (*a*) The date of commencement of the lease :————.
   (*b*) The date of termination of the lease : ————.
   (*c*) Registration number of the lease : ————.
8. Season or seasons in which the land is usually cultivated during the year : ————.
9. If cultivated for the Yala Season :
   (*a*) approximate date of sowing : ————.
   (*b*) approximate date of harvesting : ————.

10. If cultivated for the Maha Season : ————.

(a) approximate date of sowing : ————.

(b) approximate date of harvesting : ————.

11. Whether the land is cultivated by the owner/lessee/ande-cultivator or tenant under an ande-tenancy : ————.

12. (a) The amount of rent per season per annum payable in money or paddy : ————.

(b) Intervals at which the payment of such rent falls due : ————.

	During preceding Maha Season			*During preceding Yala Season*		
	Acres	*Roods*	*Perches*	*Acres*	*Roods*	*Perches*
13. (a) Extent cultivated ..	————	————	————	————	————	————
(b) Total yield ..	———— bushels			———— bushels		

(c) If not cultivated give reasons why the land could not be cultivated : ————.

DECLARATION

I do hereby declare that to the best of my knowledge and belief all the statements contained in this return are true and accurate.

Dated this ———— day ————, 195—.

————.
Signature of Owner/Lessee.

PART II

The Paddy Lands Act, No. 1 of 1953

Return under Section 8 (2)

Cultivation year, January 1, 19— to December 31, 19—

1. Name of paddy land : ————.

2. Situation :

(a) Village/kandam/tract or block : ————.
Village Headman's Division : ————.
D. R. O's Division : ————.

(b) Name of tank or Irrigation Scheme under which the land is cultivated : ————.
(If rain-fed, so state.)

(c) Vel or Kama Vidane's Division : ————.

	Acres	*Roods*	*Perches*
3. Extent	————	————	————

4. (a) Boundaries : ————.

(b) Reference to plan, lot or specification, if any : ————.

5. Name and address of owner : ————.

6. (a) Name and address of lessee: ————.

(b) Name and address of cultivator : ————.

7. (a) Date of commencement of lease: ————.

(b) Date of termination of lease : ————.

(c) Registered number of the lease : ————.

8. Season or seasons in which the land will be cultivated during the year : ————.

9. Whether the land will be cultivated by the owner/lessee/ande-cultivator or tenant under an ande-tenancy : ————.

10. (*a*) The amount of rent per annum payable in money/paddy : ————.
    (*b*) Intervals at which the rent falls due : ————.

11. Approproximate date on which the land will be sown for the first time : ————.

I do hereby declare that to the best of my knowledge and belief all the particulars contained in this return are true and accurate.

Date : ————.

————.
Signature of owner/lessee.

Note.—This return should be furnished within two weeks before the first sowing of paddy.

PART III

The Paddy Lands Act, No. 1 of 1953

Register of Controlled Paddy Lands

Cultivation Year	—— *19*— *to* —— *19*—	—— *19*— *to* —— *19*—	—— *19*— *to* —— *19*—	—— *19*— *to* —— *19*—
1. Situation of paddy land :				
(*a*) Village Headman's Division and number ..	————	————	————	————
(*b*) D. R. O's Division	————	————	————	————
(*c*) Revenue District	————	————	————	————
2. Registration number of paddy land ..	————	————	————	————
3. Name of paddy land	————	————	————	————
4. Name and address of owner	————	————	————	————
5. (*a*) Specification No.	————	————	————	————
(*b*) Boundaries of the paddy land ..	————	————	————	————
	A. R. P.			
6. Extent of the paddy land	————	————	————	————
7. If the paddy land is leased—				
(*a*) Name and address of lessee ..	————	————	————	————
(*b*) Registered number of lease	————	————	————	————
(*c*) Date of execution of lease	————	————	————	————
(*d*) Date of commencement of lease ..	————	————	————	————
(*e*) Date of termination of lease ..	————	————	————	————
(*f*) Whether tenancy is an ande-tenancy or not	————	————	————	————
(*g*) Whether the authorised rent is to be paid in paddy or money	————	————	————	————
(*h*) Intervals at which rent is to be paid and when first payment is due ..	————	————	————	————
8. Extent sown during—	A. R. P.			
(*a*) the last Maha season	————	————	————	————
(*b*) the last Yala season	————	————	————	————

9. Remarks : ————.

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TROPICAL AGRICULTURIST

Volume 110 April-June, 1954 Number 2

Published Quarterly By

DEPARTMENT OF AGRICULTURE
PERADENIYA, CEYLON

Subscription Rates

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Registered as a newspaper in Ceylon.

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(2) Articles should be divided into sections, each headed by a caption, and concluded with a brief summary, if necessary.

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(4) References should be numbered in the order quoted in text, and should contain names and initials of authors and title of book or paper.

(5) Titles of manuscripts should be brief.

EDITORIAL

The Queen Visits the Royal Botanic Gardens, Peradeniya

ON the 20th of April, 1954, Her Majesty Queen Elizabeth II and His Royal Highness Prince Philip, Duke of Edinburgh, visited the Royal Botanic Gardens, Peradeniya, during the course of their two-day stay in Kandy. This was the first occasion on which a reigning monarch of the British Throne had visited the Gardens and it was accordingly a red-letter day for all those who were in any way connected with them.

The Gardens were established in February, 1922, by Alexander Moon, the first Superintendent, who had been instructed by the then Lieut. Governor of the Island, Sir Edward Barnes, to select a suitable site for the purpose near Kandy. The site chosen was the pleasure Garden of the last King of Kandy which itself had earlier been a place of residence of one of his predecessors and a centre of worship. These facts give the Gardens an added historical interest. From time to time in its history the Gardens were visited by Royalty and other distinguished personages who, in commemoration of their visits, planted trees round the "Great Circle" lawn. Of these visitors the following may be mentioned, the name of tree planted and the year of the visit being indicated in brackets: King Edward VII (*Ficus religiosa,* Bo, 1875), the Czar of Russia (*Mesua ferra,* Ceylon Iron-wood, 1891), Prince Henry of Prussia (*Delonix regia,* Flamboyant, 1899), King George V (*Couroupita guianensis,* Cannon-ball tree, 1901), the Duke of Windsor (*Mimusops Elengi,* Munamal, 1922), King Albert of Belgium (*Amherstia nobilis,* 1925), and the Duke of Gloucester (*Monodora tenuifolia,* Orchid tree, 1929). Of local personages who have been honoured in the Gardens in this manner, mention should be made of the Rt. Hon'ble D. S. Senanayake, first Prime Minister of Ceylon, who on February 4th, 1948, planted a Tamarind tree (*Tamarindus indicus*) to commemorate Independence Day. One of the chief items in the programme of Her Majesty's visit to the Gardens was appropriately, therefore, the planting of a tree.

Sharp at 9 A.M. Her Majesty and His Royal Highness arrived at the entrance to the Gardens and were received by the Right Hon'ble the Prime Minister, Sir John Kotelawala; Sir Oliver Goonetilleke, Minister in Attendance; the Hon'ble Mr. J. R. Jayewardene, Minister of Agriculture and Food; Mr. T. B. Panabokke, Parliamentary Secretary to the Minister of Agriculture and Food; Dr. A. W. R. Joachim, Director of Agriculture; and Mr. D. M. A. Jayaweera, Superintendent of Botanic Gardens. The Superintendent then presented Her Majesty and His Royal Highness with

Her Majesty Queen Elizabeth II and H. R. H. The Duke of Edinburgh visited the Royal Botanic Gardens, Peradeniya, on the 20th of April, 1954, during their historic Commonwealth tour. Here they are seen in the Flower Garden, accompanied by the Ministers in Attendance and Officers of the Department of Agriculture.

By courtesy of the Times of Ceylon

(*Left*) The Queen plants a tree (*Ficus Krishnae* A. DC.) to commemorate her visit. Her Majesty is attended by Mr. J. R. Jayewardéne, Minister of Agriculture and Lands, and Mr. D. M. A. Jayaweera, Superintendent, Botanic Gardens. (*Right*) The Queen accepts the gift of a silver bowl and talipot palm from Dr. A. W. R. Joachim, Director of Agriculture, on behalf of the Department of Agriculture, Ceylon.

The Royal Botanic Gardens at Peradeniya will always be associated with the work of three great pioneers—G. K. Thwaites, Henry Trimen and J. C. Willis, who directed their activities for 63 years. These workers not only made valuable investigations on the indigenous flora of the Island but also by their enterprise and foresight in introducing from abroad several varieties of ornamental and economic plants, laid the solid foundations of our present-day plantation industry. To them the present Department of Agriculture, which stems from the earlier Department of Botanic Gardens of which they were the Heads and which was established only in 1912, is deeply indebted for having initiated the nucleus of a research service which has since grown to appreciable proportions.

Though the Peradeniya Botanic Gardens and its branch gardens at Hakgala and Heneratgoda have now, as a result of this development, restricted their activities to the main functions of such institutions, they endeavour to maintain the great traditions of earlier days in regard to botanical and floricultural study and research. Much work has been done on the hybridisation of *Hibiscus* varieties and appreciable advances have been made on the breeding and propagation of orchids. With the addition of more trained personnel to the staff the tempo of such activities will be increased in future. As in the past, facilities have been provided for foreign scientists to study aspects of the flora of the Island and provision is being made for these facilities to be extended in the future.

The visit of Her Majesty and His Royal Highness to the Gardens has set the seal on the popularity of this beauty spot of the Island among all classes of the population. The number of visitors to the Gardens exceeded 225,000 last year, and it cannot be doubted that this will increase appreciably in the future. The Botanic Gardens must, therefore, continue to remain a national trust under the direct control of Government and its executives. Thus only will be ensured the full and unrestricted development of an institution which has not only played a vital part in the agricultural economy of this Island over several decades, but has contributed so greatly to its fame in the fields of tourism and botanical lore.

A Survey of Agricultural Conditions in the Trincomalee Division

S. C. GUNARATNAM

Introduction

THE Trincomalee Agronomic Division comprises only the District of Trincomalee. The District is situated in the broad coastal plain in the East coast of the Island. The total area of the District is 1,038 square miles with four Divisional Revenue Officers' Divisions. The District comes under the Dry Lowland Zone. The annual rainfall is 50-70 inches and the distribution is of the usual Dry Zone type. More than 50 per cent. of the annual rainfall falls during the three months of November to January (North-East Monsoon season). Strong winds prevail during June to September and the general condition is very dry. According to B. H. Farmer the mean monthly free water evaporation in the District ranges from 12.2-17.7 inches during the months of May to September, highest recorded in the Island. The mean temperature is about 82°F. Frequently storms of great intensity but of short duration are experienced.

Land and Land for Development

The total extent of land cultivated for a season under paddy, chena crops, highland crops and village garden crops would not exceed 40 square miles, that is about 4 per cent. of the total area of the district, besides the land at present allotted to the Colonists.

The total extent of land under two major Colonization Schemes, (i) Kantalai Augmentation, and (ii) Allai Schemes, to be brought under cultivation would be about 33,525 acres of paddy land and 19,918 acres of highland, a total of 53,443 acres or about 81 square miles. The maximum extent of land that could be utilized for agricultural purposes in the District may be put down roughly as 160 square miles or 102,400 acres. There are at present four Forest Reserves totalling 178,804 acres. Two of these reserves would be utilized in the Kantalai and Allai Schemes. There is at present a proposal to have a forest reserve of 133,120 acres at Pankulam. The Kantalai and the proposed Pankulam Reserve would take up an extent of about 231,981 acres or about 362 square miles. Besides the land under cultivation and the reserved forest, there is an extent of 556 square miles of land under forest, more than 50 per cent. of the total area in the District, for land or agricultural Development purposes. A large proportion of the land could be developed in future through dry farming methods, using Colonization and Village Development Schemes.

Water Resources

A good quantity of the annual rain water varying from 50 to 70 inches has been put to agricultural use directly, or indirectly through irrigation from stored water in the tanks ; but there remain millions of acre feet of water running to waste which could be conserved or stored and used to irrigate fertile and valuable lands still undeveloped. Owing to the uneven distribution of the rainfall the flow of water in the rivers and streams of the District, except in the Mahaweli Ganga, is a mere trickle

during the major part of the year. Occasionally during the months of October to January there may be high floods in the rivers and streams.

There are several streams and rivers, the most important of which is the Mahaweli Ganga and its outlets in the delta. The river is not tapped, except its outlet, the Verugal river. At present a few hundreds of acres on its bank are being cultivated with lift irrigation during the *Yala* season. It is possible to make more efficient use of its water with more improved technique than used at present. There are also other rivers or streams such as Mora yala, Yan oya, Mee oya, and others, the waters of which now run to waste instead of being used for irrigation.

There are 5 major tanks and 65 minor tanks in the District. The most important is the Kantalai tank. It is situated near the boundary of the Eastern Province and the North-Central Province, about 25 miles south-west of Trincomalee. Its bund carries the Kandy-Trincomalee P. W. D. Road from the 86th to 89th mile posts. The tank appears to have been constructed during the reign of King Agrabodhi II in the 7th century A. D. The present capacity of the tank is 37,124 acre feet. It has about 5,000 acres developed under a primitive irrigation system. On account of floods and heavy rains during the *Maha* season, generally a *Yala* crop is taken commencing in April. Kantalai tank as it stands can store much more water than at present. To increase the tank capacity, the old channel from Minneri to Kantalai should be repaired, thus adding another 119 square miles of catchment to Kantalai. In the augmentation scheme, the present capacity will be increased from 37,124 acre feet to 140,000 acre feet and the spill of the tank will be raised.

Another important tank is the Allai tank linked with its twin Peruveli tank, by a cut channel one mile long with a control on it. The two tanks come under the Allai Scheme which is a diversion plus a storage scheme. An anicut across the Verugal river, which is a flood outlet of the Mahaweli ganga, diverts water into an inlet channel which leads into the Allai tank. The Allai Scheme irrigates at present 2,590 acres of paddy land in the Koddiyar Pattu Division of the District. At present an extension scheme is being adopted. The scheme does away with Allai Tank as a storage reservoir retaining it only for domestic purposes. The present Kallar head works will be improved and two channels on either side of the basin will be taken to command about 17,000 acres. The left bank channel is about 11½ miles long commanding 14,000 acres of irrigable land. The right bank channel which skirts the foreshore of Allai Tank is 10½ miles long irrigating 3,000 acres. The two channels will in all command 17,000 acres.

Besides the village tanks there are about 351 abandoned tanks of various sizes. A large proportion of these tanks are found on the Kaddukulam Pattu Division of the District. Some of these tanks are on the restoration list. If the tanks cannot provide an adequate supply of irrigation water for the crops they may be used as sources for direct water supply to the villagers and cattle of dry farming schemes which may be introduced in the areas. There are a number of small streams and drainage lines which could be dammed to provide small ponds of stored water.

The possibility of the use of the under ground water from wells and " Kernies " or large wells is very limited. In Trincomalee District, unlike Jaffna Peninsula, the land is floored by ancient crystalline rocks which by their nature cannot hold a large quantity of water. There are wells especially in the Kaddukulam Pattu Division which dry up altogether in the dry season when water is most needed.

It is expected that the Irrigation Department will complete the major Kantalai and Allai Irrigation projects by 1959 and in all probability take up the Yan Oya and the Pathaviya development schemes early to bring under cultivation several thousands of acres of paddy.

Population and Labour

The population of the District according to 1953 Census is 84,509, over 33 per cent. of whom are resident in the Trincomalee Urban area.

Of the total population 84,509, the number of people living in the Urban Council Town and Gravets area is 31,392. Many of these carry on pursuits other than the cultivation of land. Several thousands are employed in the Royal Naval Dock Yard. The rest of the people 53,117 in number are scattered in villages in the Tampalakamam Pattu, Koddiyar Pattu, and Kaddukulam Pattu Divisions at an average rate of 52 people per square mile.

There is ample land and abundance of irrigation facilities but the rural areas are very thinly populated especially in the Kaddukulam Pattu Division. The real cultivators who actually work on land in the rural areas would be about 17 persons per square mile, or 20 per cent. of the whole population. In Muslim villages the women do not take part or assist in the cultivation operations in the fields. A farmer is put to great hardships during the time of harvesting for want of an adequate number of agricultural labourers.

During recent years, because of the thin population of the District, it was found difficult to settle villagers on lands in sufficient numbers in the Allai and Kantalai Colonization schemes. Therefore settlers from other parts of the Island were encouraged to take up their residence in rich and fertile tracts of lands of the colonization schemes.

Transport and Communication

There are two good roads, the Trincomalee-Puttalam road about 30 miles long, and the Trincomalee-Kandy road 28 miles long. There are also two lesser grade roads, 32 miles of Trincomalee-Batticaloa road with 6 ferries intercepting it and the other 34½ miles of Trincomalee-Pulmoodai road, running north with four ferries. Of the 10 ferries only one is motorised. There are also short gravel roads joining Trincomalee-Puttalam road. All these roads are maintained by the Public Works Department. From a development point of view access by roads to rural areas is not at all satisfactory.

With the development of the Kantalai and Allai schemes it is proposed to open a suitable road joining Allai and Kantalai schemes with a ferry or a bridge across the Mahaweli Ganga. Already a jeep road has been made by the Irrigation Department connecting the two areas. The road is considered very essential for the speedy development of the land and it will be of immense value

to the future colonists of Allai and Kantalai in the marketing of their agricultural produce.

Trincomalee is very fortunate in having a first class natural harbour. As the District is being very rapidly developed it may not be very far to plan installation of commercial shipping facilities in the harbour. At present there are sailing boats and motor launch services plying between Trincomalee harbour and Mutur carrying goods and passengers.

Mutur in the South and Kuchchavely in the North are linked with telephone connections. Kantalai on the Trincomalee—Kandy road has telephone and telegraphic facilities. Villages in the West on the Trincomalee—Puttalam road and inland have no telegraphic or telephone connections.

Perishable agricultural produce is transported to and from Trincomalee to Jaffna and from Trincomalee to Kandy and Colombo by motor transport. The District is also served by railway transport by the Trincomalee—Colombo railway line.

Agriculture

Agriculture in the District may be divided into two groups. The first is the cultivation of permanent and other export crops with a view to export. The second group consists of peasant agriculture concentrated in the production of paddy and other food crops.

Of the first group only coconut is found in patches in the east coast. The tree thrives well bearing good crop of nuts. There are 9 estates with a total acreage of 2,668 acres, of which only 1,610 are cultivated. As there are suitable lands in the District the Government has taken steps to alienate Crown land to the middle class colonists and capitalists after taking into consideration the needs of peasants and reserving land for future development.

For proper development of the areas it is necessary to see that facilities like road access, nearness to postal towns, &c., are provided. Coconut may be planted all along the coastal areas to provide for the needs of local consumption, and for export if available.

Another permanent crop which is found in small extents in Koddiyar Pattu and other places is the cashew. As the trees are capable of growing in sandy tracts with very little care and water the crop may be grown extensively all along the coast of the District. As the cashew nuts are in great demand in America, Canada, &c., it has also a dollar earning value. Another crop which can be exported is groundnuts. In Tampalakamam Pattu, especially in Kinniya villages, groundnuts are cultivated to an extent of about 125-200 acres. The crop can be cultivated all over the District to produce a sufficient quantity for local consumption, and later, if possible, for export.

Of the second group paddy is the most important crop and is the staple food in the District. Of the total maximum extent of cultivable land, 40 square miles or 25,600 acres, about 24,407 acres were grown under paddy during the last *Maha* season. More than 50 per cent. of the extent are grown under irrigation schemes, the balance under *manawari* or rainfed conditions.

Table 1.—Acreage under Paddy

Year	*Yala*	*Maha*	*Total*
1950	82,962	11,945	20,907
1951	11,148	15,552	26,700
1952	11,042	16,672	27,714
1953	6,048	24,427	30,475

One of the steps taken to adopt improved methods of cultivation of paddy was the provision and distribution of pureline seed paddy to the cultivators. The selected pureline paddy for *Maha* cultivation in the District is *Vellai Illankalayan* and for *Yala* is *Pachchaiperumal.*

Table 2.—Acreage under Pureline Paddies

Year	*Yala*	*Maha*	*Total*
1949	400	740	1,140
1950	4,500	2,237	6,737
1951	6,122	4,724	10,846
1952	6,722	8,765	15,487
1953	2,330	13,317	15,647

On account of the very severe drought and lack of water in most of the tanks the total extent cultivated for *Yala* 1953 was only 6,048 acres.

Other improved methods carried out in the cultivation of paddy in the District are ploughing with model iron ploughs and tractor-drawn implements, manuring with cattle manure, green manure and fertilizer mixtures, transplanting of paddy seedlings, harrowing of the standing crop and weeding of the fields. The cultivator who was reluctant to follow these methods at first agreed to carry these out when he was convinced that there was increase in yield per acre as a result of increased yields obtained in the demonstration plots laid down by the Food Production Staff of the Department of Agriculture.

Ploughing and harrowing with tractor-drawn implements are becoming very popular especially in Tampalakamam Pattu where there are five privately owned tractors. Each of the Co-operative Agricultural Production and Sales Societies in the District has its own tractors to hire out to the members and others.

Harrowing the standing crop of paddy was a new operation in the District three or four years ago. In villages where the operation was done once or twice the cultivators were eager to have it done on a larger scale. In some villages such as the Andankulam area where about 100 acres are cultivated during the Yala season, the Food Production Staff found it extremely difficult at first to induce the cultivators to carry on the operation. At present most of the cultivators in this area are willing to carry on the operation.

Table 3.—Progress of Improved Methods used in the extensive Cultivation of Paddy

Year	*Season*	*Trans-planted Acres*	*Crop-Harrowed Acres*	*Manured Acres*	*Ploughed by Tractors and Model Ploughs Acres*	*Weeded Acres*
1948	Yala/Maha	–/1	–/10	—	–/15	—
1949	do.	–/75	–/51	–/824	50/50	–/25
1950	do.	49/39	195/291	403/729	319/574	15/158
1951	do.	55/91	323/421	769/1282	312/947	94/194
1952	do.	86/23*	703/184*	1051/1573	909/1223	61/74*
1953	do.	†10/106	†181/1136	†711/1163	963/3230	†39/384

* As the rains were late the operation could not be carried out on a large scale.

† There was not enough water in the tanks, due to the very severe drought experienced, to raise nurseries for transplanting, to harrow the standing crop of paddy, and to weed fields.

Control of Paddy Pests

In the Division paddy crops were frequently infested with the paddy swarming caterpillar *Spodoptera Mauritia* and the paddy fly *Laptocorisa varicornis* causing appreciable damage. These pests were very successfully controlled by the latest insecticides available. Paddy swarming caterpillars were successfully controlled by spraying with D.D.T. emulsions, and the paddy flies by dusting with gammaxane. Knap sack sprayers and rotary dusters were used to spray D.D.T. emulsions and gammaxane respectively.

Very good control of the paddy swarming caterpillar has been achieved by using a mist blower supplied by the Royal Dutch Shell Laboratory, Holland. This sprayer can be mounted on the shoulders of a spray operator and is power driven. D.D.T. emulsion concentrates (15 per cent. to 20 per cent. emulsions) are used with the mist blower mixed at the rate of 1½ to 2½ pints to a gallon of water. One gallon of spray is enough to spray an acre, and an operator using the mist blower on paddy fields is capable of covering 15 to 20 acres per day. A power duster is also available which can be slung on the shoulders of an operator. This duster can cover about 100 acres per day with good wind conditions using only about 3 lb. of gammaxane dust per acre. The hand rotary duster required about 7 to 10 lb. of gammaxane dust and covered only about 25 to 30 acres per day.

Subsidiary and Annual Crops

Subsidiary crops are grown extensively in chenas and in garden lands. The garden lands adjoin dwelling places and are usually grown with manioc, maize, chillie, cowpea, sorghum, vegetables, &c., with the first rains of the North-East Monsoon. Chena cultivation is confined to tracts of crown lands given to peasants. Cut and burnt chenas are grown usually with paddy and in some cases with a mixture of kurakkan, maize, chillie, mustard, &c.

Table 4.—An estimate in acres of the Crops grown in the District

Crops	*1950/51*		*1951/52*		*1952/53*		*1953/54*	
	Yala	*Maha*	*Yala*	*Maha*	*Yala*	*Maha*	*Yala*	*Maha*
Kurakkan	—	129	—	227	—	130	—	117
Maize	—	710	—	947	—	999	—	948
Sorghum	—	—	—	148	—	65	—	61
Green Gram	—	82	—	111	—	27	—	87
Chillie	—	217	128	497	141	274	91	260
Onions	—	14	63	52	47	99	21	59
Gingelly	—	161	225	63	166	60	140	239
Mustard	—	45	—	46	—	20	—	21
Manioc	—	518	—	420	—	250	—	577
Sweet Potatoes	—	50	—	51	—	53	—	75

Livestock

The Livestock population in the District as enumerated in the Census of 1946 is as follows :—

Cattle	*Buffaloes*	*Goats*	*Pigs*	*Fowls*
13,128	7,861	1,792	15	9,117

At present the number of animals and poultry has increased considerably. Except for a few draught bulls and cows the cattle in the District consist of indigenous types bred indiscriminately.

The goats in the District are of the local breed. Three Co-operative Goat Farming Societies have been formed to rear good goats in numbers as remunerative concerns which also add much towards the food drive.

The poultry in the District are mostly of the local stock. The Austrolop and the R.I.R. breeds are utilized to improve the local birds.

Buffaloes are used mainly in the cultivation of paddy. An attempt has been made to improve the local animals by crossing with Murrah stud animals.

On the banks of the Verugal river there are about 1,000 to 1,500 head of cattle, known as the Tammankaduwa cattle, bred and multiplied out of some original cattle brought from South India about 100 years ago. There was a good deal of cross-breeding of the animals with local cattle. In a place known as Kombanachchie about 22 miles from Kiliveddy on the banks of the river Verugal a large number of the present stock is found. The original animals were pure white in colour and were about 5 feet in height. The present stock is white, greyish white or brown in colour, and are about 4 to 4½ feet in height. The degeneration of the cattle in colour, height and size is due to the admixture with the short and small local cattle. A number of these cattle are semi-wild and are in very good condition. There is a great demand for these animals for draught purposes in the Eastern Province particularly in the Batticaloa District.

References

B. H. Farmer—"Some thoughts on the Dry Zone".—*A paper sent to the Ceylon Geographical Society, November 23, 1951.*

Census Report—1953.

Census Report—1946.

S. K. Thuraisingham—Agriculture in the Northern Division. *Tropical Agriculturist*, Vol. CIX, No. 4, 1953.

Administration Report of Director of Agriculture. 1952-1953.

Mechanized Preparatory Tillage of Paddy Land at Hingurakgoda Farm

H. P. B. ELLEGALA

Ploughing

THE only mechanised operation in paddy cultivation hitherto practised successfully in Ceylon has been the ploughing of fields. The first tractor that was used for this purpose was a Caterpillar D4 with mould-board plough; subsequently the disc plough was found to be superior. This was followed by lighter machines such as the international TD6, T6, and W9 tractors, all with trailed implements. Then came a quick change of both tractors and implements. The rubber-tyred Ferguson tractor was the first in the field with power lift implements. Fordson Major tractors and several others came soon after. The last to come were the Australian Government's gift tractors—the Farmalls.

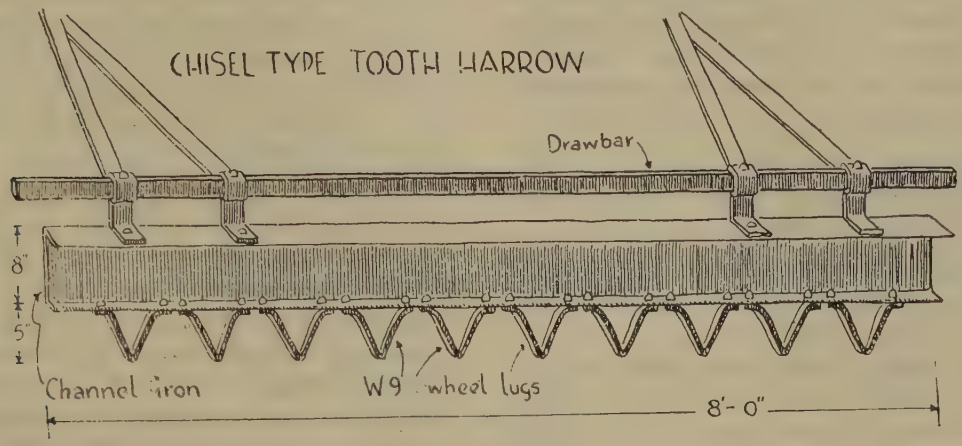
All these tractors did a satisfactory job of ploughing under reasonably good conditions. Ploughing was difficult when the land was too dry or too wet. Under the former conditions the plough skims over without a sufficient cut, and under the latter the tractor gets bogged down. However, with careful planning it is possible to get through ploughing within the time available, and if one or two crawler types of tractors with trailed disc ploughs are at hand, ploughing will not be normally a problem.

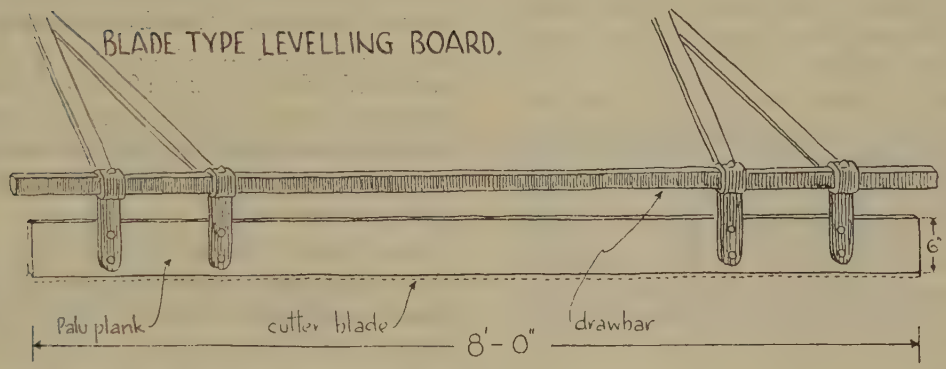
Puddling and Levelling

Ploughing is only the first operation in paddy cultivation. The other operations that follow are more difficult and less suited for mechanized operation. These are the puddling and levelling of ploughed land—never been previously done in the Island with mechanical aid. It is the experience of every paddy cultivator that unless paddy soil is thoroughly puddled or churned and then properly levelled, the resultant crop is generally poor, due to heavy weed growth competing with the rice.

We have hitherto done puddling or mudding with what is commonly called a "Burmese Harrow"—a six-foot long, six to eight inch thick round log, fitted with wooden spikes and drawn by buffaloes or bullocks—which breaks up the moist clods, buries the weeds and creates a bed of soft mud six to twelve inches deep. This operation is followed by levelling. An animal-drawn levelling board called the "poruwa" is used and the finishing touches are given by hand levelling boards just before sowing.

It is inevitable, therefore, that with the advent of tractors for ploughing paddy land, some mechanized device should be introduced to do puddling and levelling as well, to replace slow animal draught which loses the advantage gained by early ploughing.





It was this that led me to design an implement to be used with tractors. 500 acres of ploughed land at Hingurakgoda Farm were awaiting puddling, and as there was very little time left before sowing, I decided to try a tractor. I used a Farmall AM, without any implements, in a wet field. It moved freely where there was plenty of water but got bogged down in other places. I then learnt the secret. Where there was plenty of water the grooves of the rubber tyres were washed clean and the tyres were able to get a grip on the undisturbed sub-soil and so make the wheels move. In places where there was only mud, the space between grooves was filled with mud and the surface of the tyres made smooth and movement impeded. Thereafter I had all the fields flooded. This was easy, as there was plenty of irrigation water and rain.

Normally, after the rains set in, it is usual for the tractors to be put under cover. All operations in paddy cultivation thereafter proceed with animal draught and manual labour, but with this discovery I was able to use all my tractors in the fields. After I had seen that the tractors were able to move freely in flooded fields, I invented certain implements which I knew should

work satisfactorily when fitted to the tool bars of the tractors. The principle is the same as that of the "Burmese Harrow" and the levelling board drawn by animals.

Chisel Type Harrow and Blade Levelling Board

Wheel lugs from W9 tractor were fitted to an eight-inch wide channel iron frame to form the harrow.

A levelling board was made of two-inch thick "palu" timber, six inches wide and eight feet long. A cutter blade was fitted at the bottom to prevent wear on the plank.

Two cutter blades of a bull-dozer may also be converted into a very useful levelling board.

Five of these harrows and levelling boards were turned out and were fitted to the tool-bars of the Farmall AM tractors. It is of interest to note that due to the long reach of the tool-bar in Farmall tractors these implements can work right behind the rear wheels, obliterating the wheel tracks, unlike the short-reach tool-bars of other types of tractors.

These tool-bars are worked by a hydraulic lift arrangement and hence can be lifted off ground and dropped when required while on the move. The depth of harrowing and levelling too can be adjusted by the "lift" lever. Thus high spots can be levelled off and low spots filled in with ease.

Suitable Field Conditions

The following conditions should obtain for operating with rubber-tyred tractors :—

(1) There should be plenty of water in the ploughed field.

(2) The depth of mud should not be more than 1½ to 2 ft., i.e., shallow.

(3) The sub-soil should be either gravel or sand to permit a grip on the tyres.

In deep mud or where there is an insufficiency of water to wash the grooves of the tyres the tendency is for the tractors to bog down.

About three-quarters of the dry zone paddy soils are shallow, with an average depth of about 1½ feet of top soil over gravel or sandy sub-soil. It is only in gulleys or water-logged low-lying areas that deep mud is found. Such fields have to be worked by buffaloes or in some cases mamotied by hand as even animals cannot get in. Thus it can be safely assumed that about 500,000 acres in Ceylon out of a million acres of paddy land (approximately) can be mechanically prepared from ploughing up to the time of sowing.

At present these operations take 6 pairs of buffaloes per acre at a tediously slow rate, permitting the cultivation of only a limited extent as compared with 4 acres per Farmall per day. The cost of mechanical cultivation is thus about one-fourth that incurred by animal draught. These Farmall AM tractors are not only used for ploughing, puddling and levelling on this farm but are also used for threshing paddy, haulage and power take-off work for threshers, winnowers, and saw benches.

Wear on the Tractors

There is one disadvantage in working these tractors in mud, which is of some importance. Small particles of sand in the mud creep through the grease seals and wear out both the grease seals and front wheel razors. If a device to lock

these grease seals and razors can be made the wear on these parts could be considerably reduced. It has been found that a set of grease seals and razors will last one season (45 to 60 days), and for the next season a new set of these has to be fitted. However, the cost of a complete new set not being too high (about Rs. 50) seasonal replacement is not uneconomic. It works out to about 25 cents per acre or Re. 1 per working day.

Operation Costs

The following figures give the costs of operation of a Farmall AM tractor on an 8-hour working shift including costs of fuel, operator's wages and depreciation.

	Rs.	c.
(*a*) Kerosene oil $1\frac{1}{2}$ gallons per hour for 8 hours at Re. 1·10 per gallon ..	13	20
(*b*) Petrol $\frac{1}{2}$ gallon per day at Rs. 2·60 per gallon	1	30
(*c*) Engine oil $1\frac{1}{2}$ bottles per day at Re. 1·50 per bottle	2	25
(*d*) Grease, gear oil, distilled water, &c.	1	25
(*e*) Wages of operator at Rs. 5 per day	5	0
(*f*) Depreciation of Tractor and Implements (valued at Rs. 20,000) at Rs. 2 per hour for 8 hours	16	0
(*g*) Incidental expenditure per day	1	0
	40	0

Assuming that 4 acres are ploughed under suitable conditions (the D4 Caterpillar and TD6 Tractors can do a bigger extent for the same cost) the cost per acre of ploughing paddy land is Rs. 10. Puddling and levelling (both operations combined) at 4 acres per day cost Rs. 10 per acre. Thus the total cost of ploughing, puddling and levelling paddy land up to sowing, if mechanically done, is Rs. 20 per acre.

Compare this with the cost of animal draught.

	Rs.	c.
(*a*) 2 pairs of bullocks per acre for ploughing at Rs. 10 per pair per day ..	20	0
2 ploughmen and 2 helpers to lead animals in wet fields (bullocks unlike buffaloes do not move freely in paddy lands) average rate of wages Rs. 3 per head ..	12	0
(*b*) 2 pairs of buffaloes for puddling with Burmese Harrow at Rs. 8 per pair ..	16	0
and 2 ploughmen for harrowing at Rs. 4 each	8	0
(*c*) 2 pairs of buffaloes for levelling at Rs. 8	16	0
and experienced ploughmen for levelling at Rs. 4 each	8	0
Total (without any depreciation of implements)	80	0

These figures reveal that the mechanical preparation of paddy land costs Rs. 20 per acre, and the same operations by animal draught, Rs. 80 per acre. Thus, costs are reduced to one-fourth and speed increased four times.

Acknowledgment

I take this opportunity of thanking Professor Hardy, Mr. George Bryce (of the F. A. O. team) and Mr. C. R. Karunaratne, Agricultural Officer, Dry Farming for the encouragement given me and the Assistant Farm Manager, Mr. S. Thambiayah, for his co-operation and support.

(*Top Left*) Chisel type tooth harrow fitted to tool bar of tractor. (*Top Right*) Blade levelling board fitted to tool bar of tractor. (*Middle Left*) Reducing high spots in the field with levelling board. (*Middle Right*) Puddling the field with the harrow. (*Bottom Left*) Final stage of levelling. (*Bottom Right*) The old method of puddling with animal drawn harrow.

Hybridization Technique in Rice

H. WEERARATNA

Introduction

IT has become increasingly evident, that the potentialities of straight selection within varieties indigenous to Ceylon are severely limited. Rice improvement in this country must depend largely on selection within progenies of hybrids between introduced varieties and indigenous material. Further, grain shedding, weak straw, poor milling quality and low milling out-turn are some of the defects in our older, local pure-lines. The correction of these defects will depend mostly on hybridization. With rice, various techniques of hybridization have been practised in different countries. This paper presents an account of a hybridization method, succesfully practised at Maha Illuppallama and at Batalagoda. Data relating to stigma receptivity have also been included in this paper.

Emasculation of Female Parent

Numerous methods have been practised in different countries with varying degrees of success. Emasculation by clipping off the lemma and the palea is probably the oldest method, first practised in Japan. Clipped glumes, however, lead to the formation of deformed grains, and are more easily infected. Moreover, grains that set under such conditions require specialised treatment for their successful germination. In America, hot water at a temperature of 45°C. has been used with success. The use of hot air at the same temperature is also common. In Indonesia and Madagascar the suction method is widely practised for emasculation. This method too involves the removal of the upper portion of lemma and palea and hence has the same disadvantages mentioned before.The advantage of the suction method is that it is quick and greatly reduces the chances of selfing, as the removal of the anthers is done with a suction tube, without crushing them. In these methods, the use of high temperature for forcing open the glumes is necessary.

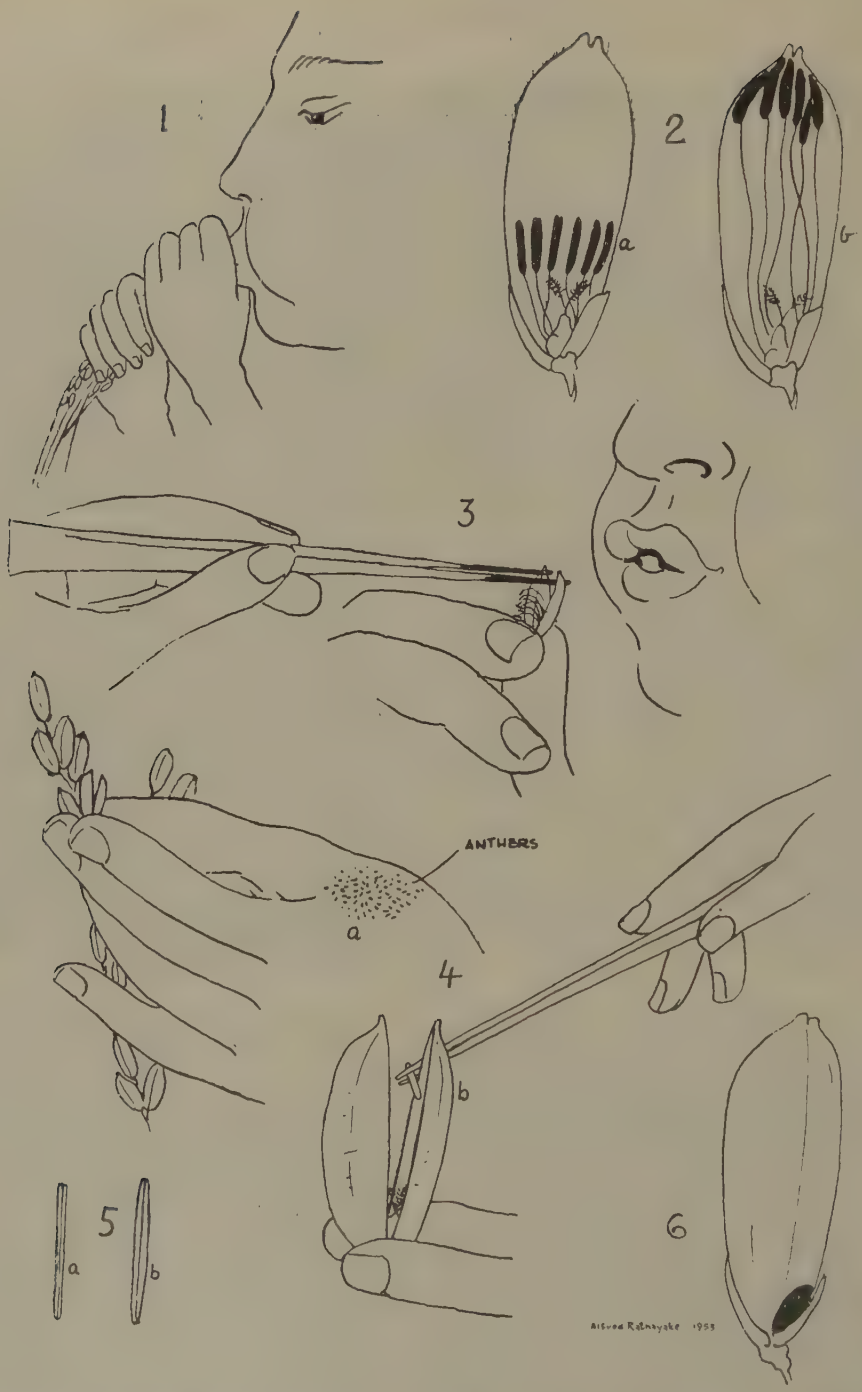
Furthermore, their use is restricted to the plant cage or laboratory, application in the field being troublesome.

In certain parts of India the insolation of panicles under black or brown paper is a simple method that is practised but the response is erratic.

The writer has found the following method completely satisfactory for adoption in the field:—

A panicle in its second day of opening (where only a few spikelets have opened) is selected. The lowermost spikelets, which are the last to bloom are clipped off, together with those which have opened previously. Absence of anthers inside the spikelet, when examined against the light, indicates that blooming has occured previously.

The panicle is covered with both hands or with a handkerchief and is subjected to hard blowing with the mouth for a period of 6-7 minutes. The panicle should be as close to the mouth as possible so that the full blast is directed on the spikelets. The panicle is



1 A panicle covered with both hands, subjected to blowing. 2 (*a*) A spikelet before blowing. Note short filaments. 2 (*b*) A spikelet after blowing. Note elongated filaments. 3 Application of gentle pressure at the bottom of the spikelet and insertion of forceps points at apiculus end opens the glumes. 4 (*a*) Opening the glumes of a spikelet. Note anthers on the back of left-hand. 4 (*b*) A ripe anther being rubbed against the inner edge of the glumes to deposit pollen on the stigma. 5 (*a*) An immature anther. 5 (*b*) A ripe anther fit for use in pollination. 6 A set grain 4 days after pollination.

turned periodically to ensure even distribution of blowing pressure over the spikelets. This treatment results in the elongation of the filaments, and the anthers on reaching the apex of the spikelet exert pressure and force the glumes open.

The stamens are then removed by their filaments with a pair of forceps, taking care not to crush the anthers. In some varieties, for example, Indian pure-lines G.E.B.-24 and Ptb-16, Indonesian pure-line *Mas*-(M-24) Chinese purelines GH-18, CH-1007 and the local pureline *Pachchaiperumal* 2462/11 the response to this method is so striking that it is often impossible to keep pace with the rate of opening of the spikelets.

In certain other varieties like *Vellai Illankalayan* 28061 the blowing treatment may lead to the elongation of the filaments, but yet, the spikelets may remain unopened. In such cases, the application of gentle pressure at the bottom of the spikelet with the thumb and forefinger or the insertion of the forceps points at the apiculus end will cause the glumes to open. The spikelet should be opened sufficiently to facilitate emasculation. Wide separation of the lemma and the palea may result in their remaining in that position without subsequent closing. Gentle blowing into the partially opened spikelet will bring all the stamens out and these are removed with a pair of forceps. If the stigma itself comes out with the stamens, it should be carefully reinserted into the spikelet, as a protruding stigma is liable to be damaged by the closing glumes. Only 20-25 spikelets should be emasculated in a panicle. At the completion of emasculation, the unopened spikelets are clipped off and the panicle is covered with a paper bag to prevent cross-pollination.

The best period for emasculation is from 6-8 a.m. Low temperature, cloudy weather and humid air retard the opening of spikelets. Under these circumstances blowing on to the panicle should be continued for a longer period. All varieties tried by me have responded to this method. The necessity for the application of gentle pressure at the bottom of the spikelet may also arise in adverse weather.

Pollination

Pollination is best done on the third day of emasculation so that accidental selfing may be detected. In the process of emasculation, a few spikelets are liable to get selfed. These can be detected by the developing ovary and removed. The best time for pollination appears to be 9-10.30 a.m.

A couple of panicles of the male parent, in the second or third day of blooming are cut and wrapped in a moist handkerchief or a piece of cloth in order to prevent them drying. Anthers for pollination should be removed only from those spikelets where the filaments have elongated and the spikelets are due to open. The glumes are pulled apart and the anthers are removed with a pair of forceps, care being taken not to crush them. It is important that the anthers after removal should be allowed to dry for a few seconds. Anthers from five to six spikelets are removed and placed on the back of the left hand between the thumb and the fore-finger or else on a watch glass. Only ripe anthers should

be used for pollination. A ripe anther can be detected by its swollen apperance.

The spikelet to be pollinated is opened by applying gentle pressure at the bottom of the glumes with the thumb and forefinger. A ripe anther is held by a pair of forceps and rubbed or crushed against the inner edge of the lemma or the palea, so that pollen is deposited on the stigma. Anthers should not be rubbed against the stigma as this will damage the stigma and ruin the spikelet. If the first anther fails to deposit pollen on the stigma, another should be used. Make sure that the stigma is completely covered with pollen grains. Pollen can easily be detected on a pigmented stigma. Though it may not be easy, yet it is not impossible to detect pollen even on a white stigma with the naked eye. Sometimes the stigma may slip out of the spikelet and remain in that position after pollination. It should be careully replaced in the spikelet or else on the subsequent release of pressure at the bottom of the glumes, the closing lemma and palea may injure the stigma.

Ater pollination the panicle is covered with a paper bag, perforated for ventilation. Grains that set can be identified by the developing ovary three to four days after pollination, by examiing the pollinated spikelets against the light.

In certain varieties, for example, the Indonesian pure-line *Mas* (M-24), development of the ovary is slow and the detection of set grains may not be possible till 6-7 days after pollination.

Set grains can be harvested 30-35 days after pollination. The writer has obtained an average set of over 50% by this method.

Specialised conditions are not essential to germinate crossed seed obtained in this manner. It is advisable, however, to disinfect the seed with silver chloride. Rice breeders often dehusk crossed seed before germination. The writer, however, has obtained almost 100 per cent. germination with unhusked seed. The seed should be tied in a piece of muslin cloth, soaked in water for twenty four hours, kept under light pressure for two days and sown in cement pots on the third day.

Receptivity of the Stigma

Published research indicates that the stigma retains its receptivity for 6 to 7 days from the date of emasculation. A gradual decline in stigma receptivity has been noted after the third day. The writer has reason, however, to believe that the duration of stigma receptivity is a varietal character.

Crosses between the Indian pure line Ptb-16 and local pure lines *Vellai Illankalayan* 28061 and *Pachchaiperumal* 2462/11 were attempted using Ptb-16 as female parent for both crosses. Pollination was done as usual on the third day of emasculation. The percentage set was alarmingly low and poor compatibility in the combinations was suspected. The reciprocal crosses, however, which gave a high percentage of set grains eliminated this possibility.

A pollination experiment, the results of which are tabled below, was then conducted to determine the duration of stigma receptivity in Ptb-16.

Female Parent	*Male Parent*	*No. of days from emasculation*	*No. of Spikelets pollinated*	*No. of grains that set*	*Percentage set*
Ptb—16	Ptb—16	3	54	35	64·8
Ptb—16	V. I. (28061)	1(same day)	27	20	74·0
Ptb—16	V. I. (28061)	2	25	12	48·0
Ptb—16	V. I. (28061)	3	73	2	2·7
Ptb—16	PP 2462/11	3	29	0	·0
V. I. 28061	Ptb—16	3	25	21	84·0
PP 2462/11	Ptb—16	3	43	36	83·7

The high percentage of set when Ptb-16 stigma is pollinated with self pollen on the 3rd day of emasculation indicates that the stigma does not lose its receptivity appreciably. With *Vellai Illankalayan* (28061) pollen, however, there is a rapid decline from 74 per cent. set on the first day to 2.7% on the third day. With *Pachchaiperumal* pollen the percentage set on the third day is nil. This decline in percentage may be explained on the hypothesis that substances inhibitory to foreign pollen accumulate on Ptb-16 stigma and reach a concentration that completely suppresses pollen germination or pollen-tube growth by the third day of emasculation. The data with the reciprocal crosses, i.e., Ptb-16 pollen on *Vellai Illankalayan* 28061 and *Pachchaiperumal* 2462/11 suggest that comparable inhibitory substances are not secreted by stigmas of *Vellai Illankalayan* and *Pachchaiperumal.*

Acknowledgment

I am deeply grateful to Dr. M. F. Chandraratna and Mr. E. Abeyratna for the guidance and advice given me for this study. I am also thankful to Mr. Alfred Ratnayake for the illustrations published.

References

J. J. Niles (1951) Hybridization methods with paddy. *The Tropical Agriculturist* Vol. C VII No. 1.

Pollination Mechanism of the Cacao Flower

J. K. GNANARATNAM

THE CACAO tree being cauliflorous produces its inflorescence on the trunk and the older branches; no flowers are produced on either the current or the previous season's growth. The flower bud first originates on cushions that arise in the original leaf axis on the old wood. The number of flower buds per cushion varies from three to twenty-five with an average of ten flower buds per cushion. From its first appearance the flower bud takes 18 to 21 days to reach normal size.

Morphology of the Flower

The cacao flower is hermophrodite with five sepals and five petals. The petals consist of a basal cup-shaped part with a ribbon like petaloid structure which terminates in a spatulate end. Petals are rosy in colour, while the ribbon part is yellowish. The stamens are five in number and are arranged alternately with 5 staminodes. The stamens, staminodes, sepals and petals are fused at the base to form a tube. The five stamens are white in colour and much shorter than the staminodes, and are curled inside the cup-like structure of the petal so as to conceal the anthers. Each stamen consists of a filament and 4 anthers. The anthers consist of pollen sacs which dehisce inside the cup-like structure of the petal.

The pistil consists of a five segmented stigma, style and ovary. The ovary is simple, oval shape, and superior in position. Dissection of the ovary shows 5 loculi with ovules on central placenta.

Biology of the Flower

A humid atmosphere is favourable for satisfactory setting of pods. Under favourable environmental conditions a fully developed bud commences to open by splitting of the sepals from 4 p.m. to 6 p.m., and continues to open throughout the night. At about 9 p.m. the flower is ¼th open with sepals unfolded and the staminodes still touching one another. By about mid-night the flower is nearly half open with staminodes separated. At about 3 a.m. the flower is ¾th open with sepals in one plane and the staminodes fully expanded. By about 5.30 a.m. the flower is fully open with the petals unfolded and the sepals expanded and reverted. The total time required for opening is from 12 to 14 hours. The stigma is receptive after opening. The flower is protogynous and exhibits incomplete dichogamy, dehiscence of the anthers taking place a few hours after the opening of the flower. At the time of dehiscence the pollen grains are released from the pollen sac into the pouch of the petals, from where they are removed by pollinating agents and transferred to receptive stigmas.

Receptivity of Stigma

The length of receptivity of stigma varies from tree to tree. In trials carried out at Kundasale on three self-compatible trees, tree No. 46 was receptive even after 24 hours of opening, while in the others the degree of receptivity was poor after 12 hours of opening. The receptivity of stigma was tested by enclosing

well developed buds in cloth-covered test tubes. The flowers were hand pollinated with pollen 2 hours after opening, 12 hours after opening and 24 hours after opening. The relevant data are given in the following table :—

Table 1

	Tree No. 46			*Tree No. 34*			*Tree No. 35*		
	No. pollinated	*No. set*	*Percentage*	*No. pollinated*	*No. set*	*Percentage*	*No. pollinated*	*No. set*	*Percentage*
2 hours after opening	28	20	71·4	27	15	55·5	10	7	70
12 hours after opening	26	16	61·5	10	7	70	18	14	77·7
24 hours after opening	20	13	65·0	25	2	8	5	0	0

Tree No. 46 is able to set pods in profusion due to the long period of receptivity, and is likely to get pollinated during both day and night.

Viability of Pollen

Dehiscence of anthers take place by bursting of the pollen sacs an hour or two after opening. At the time of liberation much of the pollen falls inside the pouch of the petal, while some being sticky remain attached to the anthers. Cacao trees show great variation in their capacity to produce pollen, some trees produce pollen in abundance while some others produce little or no pollen. Tree No. 46 a self-fertile tree and tree No. 11, a self-sterile tree produce pollen in plenty. Tree No. 15 another self-sterile tree produces very little pollen, while a completely sterile cacao tree produces no pollen at all. The viability of the pollen was tested on self-compatible trees by hand-pollinating guarded flowers, using pollen from freshly opened flowers 12 hours after opening, and 24 hours after opening.

Table 2

	Pollinated flowers	*Flowers on after 6 days*	*% set*
1. 2 hours after opening	93	60	64·5
2. 12 hours after opening	44	30	68·1
3. 24 hours after opening	15	1	6·6

The pollen grains remain viable for a period of 12 hours after which they seem to loose their viability. Pollen grains from tree No. 46 (self-fertile) and tree No. 11 (self-sterile) were sown two hours after opening in nutrient agar containing 2% agar and 5% dextrose ; germination was noticed in both cases 48 hours after sowing. Germination counts taken on different groups at random in both cases revealed a high percentage germination. It is possible that the pollen may germinate much quicker on the stigma of the flower.

Table 3

	Tree No. 46			Tree No. 11		
Group No.	No. of pollen grains seen	No. germinating	Percentage	No. of pollen grains seen	No. germinating	Percentage
1.	22	14		29	13	
2.	13	12		9	8	
3.	15	7		14	6	
4.	19	8		10	10	
Total	69	41	59·4	62	37	59·6

Pollination

Cacao is normally cross-pollinated. The superior position of the ovary and the curling of the stamens inside the pouch of the petal do not permit pollen to fall on the stigma without the assistance of a pollinating agent. The trials carried out at Kundasale to find out whether any self-pollination took place by enclosing well-developed flower buds with cloth-covered tubes showed that the flowers remain on the tree from 24 to 96 hours after opening after which they wither and drop.

Table 4

Tree No.	No. of flowers enclosed for selfsetting	Number of flowers on after opening				
		24 hours	48 hours	72 hours	96 hours	120 hours
1	9	9	6	4	2	0
2	8	6	5	4	1	0
42	13	13	12	10	6	0

The falling off of so many flowers is not due to defective floral parts, but due to lack of adequate pollination ; self-incompatible trees bear flowers in abundance and the falling off of unfertilized flowers is more conspicuous in them than in self-compatible trees.

The pollinating agent for cacao has not been determined with certainty. It is not clear as yet whether the flower is entomophilous (insect-pollinated) or anemophilous (wind-pollinated). The chances of wind-pollination are remote as the anthers dehisce inside a cup-like structure of the petals, and pollen for wind-pollination has to be produced in abundant quantity. The possibility of wind-pollination cannot altogether be excluded. The flower attracts insects such as midges, thrips, aphids and ants. Red ants which normally crawl on the tree in search of mealy bugs do not seem to assist in bringing about pollination as a number of flower buds enclosed on self-compatible trees with red

ants in cloth-covered tubes failed to set. Red ants are too big to reach the pollen from the pouch of the petal. Small black ants may probably help to some extent in bringing about pollination in self-compatible trees. Crawling insects may act as pollinating agents on self-compatible trees, but pollination taking place on self-incompatible trees necessarily implies activity by a disseminating agent. The disseminating agents may be either wind or flying insect but most probably the latter. Midges are found in plenty during the blossoming period and may help in pollinating both self-compatible and self-incompatible trees.

Studies on Pollen Compatibility

In cacao, a considerable number of trees show incompatibility between the pollen and pistil of the same plant. All the provisionally selected trees at Kundasale were tested for pollen compatibility by controlled hand-pollination. Controlled hand-pollination was carried out by enclosing well-developed flower buds, one in each cushion, with cloth-covered test tubes which were held in position with rubber bands and putty. The pollination was carried out in the morning as the flowers opened using freshly opened flowers as the source of pollen. The method of pollination was to rush the anthers on the stigma. One flower is sufficient to pollinate one to two flowers at a time. Any flowers that remained on the tree 6 days after pollination were regarded as *Set*. If the flower is fertilized, a definite swelling of the ovary is seen with fresh persistent sepals. In unfertilized flowers, the sepals are not fresh and the whole flower withers and falls off by this time.

Out of 19 trees tested, for pollen compatibility, only 5 trees were found to be self-compatible as would be seen from Table 5.

Table 5

Tree No.	*No. of flowers pollinated*	*No. set after 6 days*	*Percentage*	*Remarks*
1	20	0	0	Self-incompatible
11	36	0	0	do.
15	20	0	0	do.
17	10	0	0	do.
18	10	0	0	do.
34	37	22	59·4	Self-compatible
35	10	7	70	do.
36	13	7	53·8	do.
44	10	0	0	Self-incompatible
46	64	43	67·1	Self-compatible
63	10	0	0	Self-incompatible
77	10	0	0	do.
101	15	11	73·3	Self-compatible
114	20	0	0	Self-incompatible
115	25	0	0	do.
118	10	0	0	do.
121	20	0	0	do.
132	10	0	0	do.
133	10	0	0	do.

The following cross-pollinations (see Table 6) were made to test the cross-compatibility :—

Table 6

Female	*Male*	*No. of crosses made*	*No. set after 6 days*	*Percentage*	*Remarks*
101	46	15	7	46·6	Cross-compatible
46	101	16	10	62·5	do.
11	35	10	10	100	do.
35	11	10	8	80	do.
34	11	10	5	50	do.
11	34	5	4	80	do.
1	11	10	0	0	Cross-incompatible
11	1	10	0	0	do.
15	77	10	0	0	do.

Trees No. 101, 46, 35, 34, 36 are both self-compatible and cross-compatible, while others are self-incompatible but cross-compatible with self-compatible trees. Two self-compatible trees are always cross-compatible. Two self--incompatible trees are generally not cross-compatible. Self-incompatible trees set pods satisfactorily when pollen from self-compatible tree is used. Self-compatible trees set pods with pollen from self-incompatible as well as self-compatible trees, and therefore are apparently able to set more freely than the others. Self-incompatible trees set all their pods as a result of cross-pollination.

Self Compatibility and its Effect on Yield

The presence of self-compatible trees in a field has a definite influence over the yield of the crop. Since they set pods with pollen from any trees, they produce a heavy crop as compared to self-incompatible trees which are productive only when situated in the midst of self-compatible trees.

All the self-compatible trees under observation at Kundasale have produced more than 100 pods during the last cropping season as indicated in the following table :—

Table 7.—Yield in Number of Pods

Tree No.	*Aug. 52–July 53*	*Sept. 53–Oct. 53*
34	152	34
35	126	40
36	173	44
46	131	125
101	239	285

Sterility among Cacao Trees

The cacao population is of a heterogeneous type which includes heavy yielders, low-yielders and non-yielders. Under the last category comes the so called sterile tree. The sterility in cacao may be due to self-incompatibility in which case the sterility is conditional, or it may be due to structurally sterile organs.

While surveying the cacao trees at Kundasale to select high yielding clones, a barren type of cacao tree was noticed. This tree is very vigorous in growth as compared to its neighbour and flowers very profusely. It produces numerous vegetative shoots from the flowering cushions, and they in turn produce flowers. The pods or the pseudo-cherelles are set in profusion. The cherelles grow to varying sizes and wilt before reaching the size of a capsicum.

Floral Morphology

The flower is hermoprodite with its non-vital floral members similar to that of a bearing tree. The stamens are normal in appearance except that the pollen sacs are absent and the anthers constitute a mass of dis-organized cells indicating that the tree is male sterile. It was thought that the failure to set pods may be due to lack of adequate pollination but a number of cross-pollinations carried out with pollen from self-compatible trees failed to bring about any set indicating that the tree was female sterile as well.

Table 8

	No. pollinated	*No. set*
♀ Sterile Cacao × 36 (self-compatible) ..	.. 20 ..	0
♀ Sterile Cacao × 46 (self-compatible) ..	.. 15 ..	0

Dissection of the ovary shows 5 loculi with few ovules massed at the base of the ovary. In some cases the loculi were absent, and instead there was a central cavity with few ovules. The ovules were small in size as compared to ovules from fertile trees.

Some of the flowers set and produce malformed cherelles but no seeds develop in them. Such trees should be removed from the field or may be bud-grafted at ground level to desirable types.

Summary

This paper deals with the flowering habit of the cacao tree with reference to the mechanism of pollination. The morphology of the cacao flower clearly shows that the flower is more adapted to cross-pollination than self-pollination. From the trials carried out at Kundasale it was evident that the flowers do not set any pods without the aid of any pollinating agent to bring about pollination. It is not clear as yet whether the flower is entomophilous or anemophilous

but the chances of wind-pollination are remote as the anthers of the cacao flower dehisce inside the cup-like structure of the petals.

Pollen compatibility and its effect on the yield of the crop is also discussed. Self-compatible trees produce a heavy crop as compared to self-incompatible trees which are productive only when situated in the midst of other self-compatible trees. The self-compatible trees are generally cross-compatible with self-incompatible trees but two self-incompatible trees are not cross-compatible.

Reference is also made to the occurences of sterility among cacao trees, the cause of sterility and the uselessness of such types to a cacao grower. The sterility may be due to (1) self-incompatibility (2) structurally sterile organs.

Acknowledgment

My grateful thanks are due to Mr. A. V. Richards, Horticultural Officer, for his invaluable suggestions and encouragement which made this study possible.

References

VAN HALL, C. J. J.—Cacao.

RICHARDS, A. V.—Progress of selection work on Cacao.

The Tropical Agriculturist Vol. CIX, No. 1, 1953.

Cacao Information Bulletin—Turrialba—Vol. 1, No. 13, Nov. 1948.

Part III–Indigenous and Exotic Drug Plants grown in Ceylon *

D. M. A. JAYAWEERA

Calamus

THE dried rootstock of *Acorus calamus* Linn, (S. Wadakaha ; T. Vashambu ; Skt. Vacha ; E. Sweet Flag), a plant belonging to the family Araceae and indigenous to N. America, Eastern Europe and Central Asia, constitutes the Calamus of commerce. It is also cultivated throughout India and Ceylon, It is a semi-aquatic perennial herb with creeping much branched aromatic rhizome, .75 to 1 inch in diameter. The unpeeled rhizome, wrinkled longitudinally, is covered with a thin brown epidermis on the surface of which at regular intervals it bears triangular leaf scars which encircle the stem.

The plant bears long, narrow, dark green acute leaves thicker in the middle. The flowers are inconspicuous borne in a slightly curved green spadix covered over by a long narrow spathe.

It thrives best in moist clayey loams and alluvial soils and yields about 1½ tons of dry rhizome per acre under cultivation.

History. Calamus or Sweet Flag root was known as a favourite medicine in India from the earliest times. Celsus in the first century mentioned *Calamus Alexandrinus* the drug as probably brought from India by way of the Red Sea. It was reported that Calamus was in cultivation in Poland from the 13th century and in Germany from the 16th century.

Composition. The rhizome contains 1.5-3.5% aromatic oil the chief constituent of which is asaryl aldehyde and an amorphous bitter glucocide, acorin in addition to large quantities of starch and traces of tannin.

Uses. According to the Ayurvedic System of Medical practice Acorus is used as a remedy for many diseases such as colic, chronic diarrhoea, dysentry, bronchial catarrah, haemorrhage following abortion, intermittent fevers and insanity. Also it is used as an antidote against croton poisoning. In the Western System it is used as a carminative and a stimulant for increase in appetite. Further it has insecticidal properties and the dust is used against fleas, bed bugs, lice, moths and white ants.

Calotropis

This consists of the dried bark of the roots of *Calotropis procera* (Lit) R. Br. and *Calotropis gigantea* (Linn) R. Br. ex Ait. shrubs belonging to the family Asclepiadaceae, indigenous to India, whilst the latter only occurs in Ceylon by roadsides and waste land in the low-country and abandoned chenas in the dry zone. *C. gigantea* R. Br. (S. Wara ; T. Manakkovi, Errukalai, Urkkovi ; Skt. Arka, Mandara), the only species

* Parts I and II of this series were published in the *Tropical Agriculturist*, Vol. CI, July-September, 1945, and Vol. CVIII, No. 2 April-June 1952.

indigenous to Ceylon is an erect shrub reaching a height of about 10 feet with a yellowish white bark and stout cylindrical stem. Leaves are nearly sessile, large, oval-oblong, thick and glaucous green. Flowers occur in bifurcate cymose inflorescences and are unscented, pale purple or white in colour with spreading corolla lobes.

History. Calotropis appears to have been in use in India before the Christian era while no mention of this is made by any of the Greek or Roman writers. Playfair in the early 19th century recommended this drug for elephantiasis and its efficacy was later commended on by Vos (1826), Cumin (1827) and Duncan (1829).

Composition. The root bark contains β—amyrin and two isomeric chrystalline alcohols giganteol and isoganteol and insoluble matter, while the latex also contains β—amyrin and two isomeric resinols α—and β—calotropeol in ester combination with acetic and isovaleric acids. It also yields gigantin, a cardiac and fish poison and traces of glutathione and a proteoclastic enzyme similar to papain.

Uses. All parts of the plant are used in the Ayurvedic System of medical practice. The root bark is used for dysentery, chronic rheumatism, jaundice, syphilis, elephantiasis ; the latex of the stem as a purgative, and for leprosy and dropsy. Flowers for digestive troubles, asthma and cough and the leaves for eczema and skin eruptions. Various parts of the plant are used for snake bites. In the Western System only the root bark is employed as a diaphoretic and expectorant in small doses and as a substitute for ipecacuanha. The bark yields a strong durable silky fibre used for making fishing nets and lines.

Calumba

This consists of the dried slices of the roots of *Jateorhiza palmata* Lam. a climbing plant indigenous to Portuguese East Africa abundantly growing in the forests near the Zambesi. It is yellowish brown in colour externally but internally yellow. In its native home the stem is used as a cure for dysentery.

A very good substitute for Calumba is found in the stems of *Coscinium fenestratum* Colebr. (S. Weni-wel, Ban-wel-geta ; T. Maramanjal ; E. Tree turmeric ; Skt. Daruharidra) also a woody climbing plant indigenous to Ceylon and S. India belonging to the Family Menispermaceae. Its bark is smooth and the young shoots are finely tomentose. Leaves are large, broadly ovate, subcordate or slightly peltate at the base, glabrous above and densely covered with fine yellow tomentum beneath, strongly 5-7 nerved, prominent beneath, borne on petioles of 3-4 inches in length. Flowers, male and female, yellow in colour and arranged in small long-stalked densely rounded heads umbellately or racemosely placed in the axils of leaves.

History. The stem of this plant has been in use in S. India and Ceylon as a bitter tonic and a yellow dye for a long time though the exact origin of its uses is not known. Some of it seems to have found its way to Europe and found suitable as a substitute for Calumba and hence refered to a False Calumba, Ceylon Calumba or Tree Turmeric.

Composition. Coscinium contains a yellow crystalline alkaloid Berberine, Saponin and traces of ceryl alcohol hentriacontane, setosterol, palmitic and oleic acids, sisterol glucocide and some resinous material.

Uses. Coscinium is administered as tincture or infusion for fevers and certain forms of dyspepsia. Owing to its antiseptic properties it is used for dressing wounds and ulcers. It is a suitable substitute for Berberis. In the Ayurvedic System it is considered as a specific for immunisation against tetanus and it seems to have the same effect as an injection of Tetanus Toxoid.

Cambogia—Gamboge

Gamboge is obtained as a resinous gum from the bark of *Garcinia Hanburii* Hook, a moderate sized tree found in Siam, Cambodia and Cochin China. The Indian gamboge, having the same properties, is obtained from *Garcinia morella* Desr. (S. Kanagoraka ; T. Makki-maram, Korakapuli ; Skt. Tamala, Tapiccha, Tapinja) a dioecious tree, belonging to the Family Guttiferae, with handsome laurel-like foliage bearing small, greenish white, sessile flowers borne in the axils of fallen leaves. This tree thrives in moist low-country up to an elevation of about 2,000 feet in Ceylon.

History. Gamboge was known to the Chinese from the 13th century but it was regarded as poisonous and scarcely employed. Clusius mentions its occurrence in Europe and describes a specimen brought from China by the Dutch Admiral Van Neck in 1603.

Composition. Gamboge contains 70-80% resin and 15-25% gum. From the resin α, β, and γ—garcinolic acids have been isolated and the gum contains an oxydase.

Uses. The drug produces purging and in large doses vomiting. It is employed as a powerful hydragogue cathartic and also in dropsical conditions and cerebral congestion.

The dried pericarp of the fruit is used for culinary purposes practically in every household in Ceylon especially for preparation of fish dishes and also for salting fish and meat.

Camphora—Camphor

Camphor is a crystalline ketonic substance obtained from the wood of *Cinnamomum Camphora* Nees. and Eberm. (S. Kapuru ; T. Karppuram, Shudan ; Skt. Karpura) a handsome dense topped tree grown in Formosa, Japan and Central China belonging to the family Lauraceae. The tree is stout with an enlarged base, reaching a height of about 40 feet. Leaves are alternate ovate-elliptic, acuminate, young leaves pinkish, each leaf with a pair or more of strong side veins and aromatic. Flowers are small, yellow, in axillary panicles. Fruit is a drupe, the size of a large pea.

For extraction of Camphor the wood of the tree including its roots is cut into small pieces and subjected to steam distillation. The solid Camphor separates out when the oil is cooled. Camphor is crystalline colourless, transparent solid with an aromatic odour. It burns with a bright smoky flame, volatalises at ordinary temperature and sublimes when heated.

History. In China, Camphor has been prepared and used from the earliest times. It is mentioned in the Koran as a refrigerant in connection with the beverages of the blessed in paradise. There is no record to indicate that it was known to the early Greeks and Romans.

Marco Polo towards the end of the 13th century saw the trees which produce camphor in the forests of Fokien

in South-eastern China. In Europe it was regarded as one of the most rare and precious perfumes. It is mentioned in 636 A.D. with musk, ambergris, and sandal wood among the treasures of Chosroes II, of the Sassanian dynasty of Kings of Persia, in the palace at Madain on the Tigris, north of Babylon. In about 642 A.D. it is recorded that Indian princes sent camphor as gifts to Chinese Emperors. Between the years 1342 and 1352, the Great Khan of Pekin sent camphor along with other presents to Pope Benedict XII. Camphor was first known in Europe as a medicine by about the 12th century.

Composition. Camphor contains an exceedingly complex mixture of hydrocarbons and other substances belonging to a large number of classes of chemical compounds. The main constituents are Camphor, acetaldehyde, Dextro-pinene, Phellandrene, Cineol, Dipentene, Terpineol, Safrol, Eugeneol, Cadinene and Blue oil.

Uses. Camphor is used as an ingredient in the preparation of liniments for external application in the treatment of muscular strains, rheumatism and inflammation. Internally it is given as a carminative and antiseptic and hypodermically in the treatment of myocarditis.

Capsicum

This consists of the dried ripe fruits of *Capsicum minimum* Roxb. (E. Bird chillie ; S. Kochchi-miris ; T. Milagay) a small erect shrub, belonging to the family Solanaceae, indigenous to Tropical America and cultivated or found semi-wild in Africa, South America, India, Ceylon, &c. The fruit is small oblong-conical, 12-25 m.m. long and has a dull orange red colour when ripe. It is two-celled and encloses 10-20 flat reniform seeds. It has a strong odour and pungent taste.

History. The earliest reference to Capsicum is found in a letter written in 1494 A.D. by Chanca, physician to the fleet of Columbus in his second voyage to West Indies. In 1514 A.D. Gonzalo Fernandez de Oviedo who made a voyage to Tropical America from Spain describes the uses of Capsicum in detail.

Composition. Capsicum contains about 0.14% of the pungent principle Capsaicin, fatty oil and traces of a liquid alkaloid.

Uses. It is used internally as a stimulant and a carminative especially in flatulent dyspepsia. With other drugs such as nux-vomica or cinchona it is sometimes used in the treatment of alcoholism. Externally it is a counter-irritant and used for treatment of rheumatism, lumbago and neuralgia and as ointment in synovitis and rheumatoid arthritis.

Cardamomum—Cardamom

Cardamom consists of the dried ripe fruits of *Elettaria Cardamomum* Maton. (S. Ensal ; T. Ella-kai ; Skt. Ela) a plant belonging to the ginger family (Zingiberaceae). It is a perennial 6-12 feet in height with large lanceolate leaves on sheathing stalks. Two distinct varieties of this species are recognised. They are (1) var. *minuscula* Burkill a native of S. India and cultivated on the Malabar coast and Ceylon, (2) var. *major* Thwaites, native to Ceylon.

The fruit is a three sided three celled capsule striated longitudinally 1 to 2 cm. in length and pale buff in colour. Each

cell has two rows of seeds borne on an axile placentra. The seeds are brown, angular and hard. The spicy odour and taste are characteristic features of the seed.

History. Cardamom was mentioned as one in the list of Indian spices that were liable to duty at the Roman custom's house in Alexandria between 176 and 180 A.D. It was also mentioned by Edrisi as a product from Ceylon about 1154 A.D. According to Fluckiger and Hanbury, Barbosa a Portuguese navigator (1514 A.D.) was the first to state correctly, Malabar coast as the country of origin of cardamoms. Garcia de Orto physician to the Viceroy at Goa 1563 A.D. mentioned of a larger variety of Cardamoms as produced in Ceylon.

Composition. The seed contains a volatile oil, (cineole, limonene and terpineol combined as formic and acetic estlers) and is rich in starch.

The oil of Cardamom (Oleum Cardamomi) is obtained by the distillation of the fruits of cardamons. It is a colourless or pale yellow liquid with an aromatic odour and cooling taste.

Uses. The seed is used as a masticatory and a flavouring agent. It is supposed to possess aphrodisiac powers. Medicinally the oil is used as a carminative.

Carum—Caraway

Caraway consists of the dried ripe fruits *Carum carvi* Linn. (S. Kaluduru ; T. Pillappu-siragam ; Skt. Shushava) a biennial erect plant about two feet in height belonging to the family Umbelliferae. It is indigenous to and cultivated in Central and Northern Europe and Asia. The plant has triangular much branched leaves and thick tuberous roots. It produces compound umbels of numerous small white flowers and oblong, laterally compressed slightly curved brown cremocarps tapering toward both ends. It thrives well in well-tilled rich humus soils and require a dry temperate climate. The yield may be as high as 20 cwts. per acre but the average is about 11 cwts. per acre.

History. Caraway was known to the Arabians who called it *Karawya* by about the 13th century and it was compared to cumin and anise. About the same period it appeared under the name *Cumich* in two German medical books. It was in use in England towards the end of the 14th century.

Composition. Caraway contains a volatile oil, a fixed oil and protein. The oil of Caraway obtained by the distillation of freshly crushed fruits occurs as a colourless or pale yellow liquid with a peculiar odour and spicy taste. The oil contains a mixture of ketones, carvone, dl-limonene and traces of carvacrol.

Uses. Caraway is used as a carminative medicinally and for flavouring purposes in making bread, cheese, liquors, etc., and in the manufacture of perfumes and soap.

Caryophyllum

Clove consists of the dried unexpanded flower-buds of *Eugenia aromatica* Baill (*Eugenia caryophyllata Thb., Caryophyllus aromaticus* L.), (S. Karabu. T. Kirambu crambu ; Skt. Lavanga) a beautiful evergreen tree, 30 to 40 ft. high belonging to the family Myrtaceae. It is indigenous to Moluccas but cultivated now in Guiana, Penang, Sumatra, Zanzibar, Madagascar and the West

Indies. It was established in Ceylon before the arrival of the British in 1796. During January the tree bears numerous small greenish white flowers in trichotomous cymes. The petals fall off as soon as the flower opens and the inferior ovary is divided at the top to four tooth-like sepals.

History. The Chinese appear to be the earliest to recognise the value of cloves as a spice. It has been mentioned by several writers as been in use under the Han dynasty 266 B.C. to 220 A.D. During this period officers attending court were compelled to hold the spice in their mouths before addressing the king so that their breath might have an agreeable odour. Pliny was the first European writer to mention this spice as occuring in India. Vignoli had recorded that Emperor Constantine presented St. Sylvester, Bishop of Rome 314 to 335 A.D., 150 pounds of cloves along with other gifts. Subsequently various writers such as Cosmas Indicopleustes 547 A.D., Ibn Khurdadbah 869 to 885 A.D. Marco Polo, etc., have made mention of the spice in various works.

The Portugese held the monopoly of the clove trade till 1605 when the Dutch took exclusive possession of the Moluccas. The Dutch were very jealous of these plantations and took every precaution to see that no plants or seed ever left these islands. However the French eluded their vigilance and in 1770 introduced the clove tree to Mauritius and thence to Cayenne in 1773 and to Zanzibar towards the end of the century thus breaking the Dutch monopoly of the clove trade.

Composition. The aromatic properties of the clove are due to a volatile oil referred to as Oleum caryophylli—oil of clove—in pharmacy in addition to which it contains a little starch, tannin and a crystalline substance.

Oil of clove is obtained by the dry stem distillation of cloves and occurs as a colourless liquid which darkens with age and exposure to air. The constituents of this oil are eugenol, sesquiterpene caryophyllene, furfural, vanillin, methyl salicylate and acetyleugenol.

Uses. Clove is used medicinally as a stimulant and carminative in the treatment of flatulence and dyspepsia. It is also employed as an adjuvant to other medical preparations. Among the indigenous population it is chewed with betel to flavour the breath and probably its antiseptic properties may account for the sound teeth in betel chewers up to ripe old age.

The oil is used as a preservative and a local antiseptic in dentistry. Hence it is much used for flavouring tooth-pastes.

Applied externally it is a rubefacient and counter-irritant. It is also used in the preparation of liniment for treatment of bronchitis, whooping-cough and rheumatism. In microscopy it is used as a cleaning agent.

Commercially it finds a place in the perfume industry.

Cassiae Fructus—Cassia Fruit

The Cassia fruit consists of the ripe pods of *Cassia fistula* Linn. (S. Ehela ; T. Tirukkontai, Kavani ; Skt. Suvarnaka, Rajataru ; E. Indian Laburnum) a moderate sized deciduous tree, belonging to the family Leguminosae, indigenous to India and Ceylon and naturalised in Tropical Africa, South America and West Indies. The tree is sometimes cultivated as an ornamental tree on

account of its beautiful foliage and bright yellow flowers which occur in very lax, long-stalked, pendulous, axillary racemes longer than the leaves. The fruit is 1 to 2 feet long, pendulous, cylindrical, ¾ to 1 inch in diameter, hard, smooth, shining chocolate brown to purlish black in colour, indehiscent and contains 25 to 100 horizontal seeds immersed in a dark coloured pulp completely separated by thin transverse partitions.

The tree is very common towards the dry regions in Ceylon.

History. The name *Cassia* was originally applied by early Greeks and Romans to a bark related to cinnamon. Scribonius Largus, a physician of Rome during the reigns of Tiberius and Claudius, makes mention of it. He is said to have visited Britain with Emperor Claudius in 43 A.D. The *Cassia fistula* of modern medicine was first noticed by Joannes Actuarius who flourished at Constantinople towards the end of the 13th century. It was a familiar remedy in England in 1568. The tree was noticed by the famous traveller Belon in the gardens of Cairo in 1553 and by Prosper Alpinus in Egypt in 1592.

Composition. The Cassia pulp which is obtained from the fruit by aqueous extraction in the form of a soft paste contains mucilage, pectin, hydroxymethyl anthraquinones and large proportion of sugar. The root bark which contains besides tannin, phlobaphenes and oxy-anthraquinone substances is used as a substitute for Cassia Beareana Liquidum in the treatment of black water fever.

Uses. Cassia is used as a laxative and as an ingredient of confection of Senna. It is rarely used alone.

Catechu nigrum—Black Catechu

This is a dried aqueous extract prepared from the heartwood of *Acacia catechu* Willd. (E. Black Catechu ; S. Rat-kihiri ; T. Kadiram, Vodalia, Vodalam ; Skt. Khadira, Dantadhavana) a tree about 30 to 40 feet in height, 4 to 5 feet in girth with straggling spiny branches and feathery foliage belonging to the family Leguminosae.

It bears pale yellow sessile flowers in peduncled 1-4 nate axillary spikes. Pods are stalked 2 to 3 inches long, brown shining, carrying a triangular beak at the apex. It is indigenous to India and Burma while *Acacia Suma* Kurz also a source of Catechu grows in the hotter and drier parts of Ceylon.

The extract is dark brown in colour hard and brittle while the drug is odourless and tastes bitter at first becoming sweetish later.

History. Barbosa in 1514 mentions a drug called *Cacho* as an article of export from Cambay to Malacca and it is quite possible that it is the same as Catechu. About fifty years later Garcia d'Orta gave an account of the drug and its method of preparation. In spite of these accounts it was not known in Europe till the latter half of the 17th century when it was bought from Japan, G. W. Wedel of Jena in 1671 noticed it as a useful medicine and there was diversity of opinion whether it is of vegetable or mineral origin which was cleared by Cleyer who had a personal knowledge of China and was aware of its consumption for mastication in the East.

Composition. Black catechu contains catechutannic acid, acacatechin and isomer, quercetin and catechu red.

Uses. It is a powerful astringent. It is used internally in composition with other drugs in the treatment of diarrhoea and haemorrhage from the alimentary canal.

Chenopodium

This consists of the dried fruit of *Chenopodium ambrosioides* Linn. Var. *anthelminticum* Gray a perennial erect plant belonging to the family Chenopodiaceae abundant in Southern U. S. A. and Central America. A very suitable substitute to this American form is found in the typical species *C. ambrosioides* Linn. from which it is not very distinguishable owing to the presence of numerous natural intergrades. One distinguishing feature, however, is that the flower spikes in *C. ambrosioides* Linn. are leafy while those in Var. *anthelminticum* are not so. *C. ambrosioides* Linn. is a much branched herb 2 to 4 feet in height, strongly aromatic, occuring in Bengal, Sylhet, South India and as a common weed in Ceylon in Dimbula and some other upcountry districts probably introduced during the construction of the railway and first noticed in 1882. The flowers are minute clustered in leafy spikes the entire plant possessing a camphoraceous odour. Fruits are globular, slightly compressed and seeds very small.

History. There is no record of the drug been in use in earlier times.

Composition. The Indian chenopodium oil extracted from the fruits of *C. ambrosioides* Linn. contains besides ascaridol, p-cymene, terpenene, $\triangle$ 2-8 (9) menthadiene and traces of butyric acid, safrole, methyl salicylate, Vitamin C, and magnesium sulphate. All parts of the plant contain saponin.

Uses. The oil is effective against many forms of intestinal parasites and hookworm infections both in man and in animals such as dogs, cats, horses and etc.

Cinchona

Cinchona is the dried bark of various species of *Cinchona* Linn. (Family Rubiaceae) which are indigenous to South America. Some of these species are cultivated in Java, India, Ceylon, Burma and Tanganyika. The genus includes about 65 species of evergreen shrubs and trees, carrying opposite leaves and deciduous stipules. Flowers are borne in terminal panicles, each flower bearing a 5-toothed superior calyx and a tubular corolla expanding into five lobes fringed at the margin. The corolla has an agreeable fragrant odour and is white or rosy pink in colour. The ovary is two celled with numerous ovules on a linear axile placenta, the ripe capsules opening septicidally from the base upwards.

From a pharmaceutical point of view there are two distinct kinds of Cinchona.

(1) *Cinchona ledgeriana* Moens and its hybrids. The bark of these varieties contains 6-7 per cent. alkaloids of which 1/2 to 2/3 is quinine.

(2) *Cinchona succirubra* Pav. ex Klotzsch and its hybrids. The bark of these varieties contains the alkaloid Cinchonidine in greater proportions.

History. The early history of cinchona is not clear for the inhabitants of Peru never made use of the bark in their medicine. Joseph de Jussieu who visited Loxa in 1739 states that the use of the

remedy was first known to a Jesuit missionary who was striken with intermittent fever. He was cured by the bark administered to him by an Indian. The Spanish corregidor of Loxa, Don Juan Lopez de Canizores too is said to have been cured of his fever in 1630 by the same treatment. In 1638, the wife of the Viceroy of Peru, Luis Geronimo Fernandez de Cabrera of Bobadilla, fourth count of Chincon, was cured of her fever by a packet of the powdered bark sent by the same corregidor of Loxa from Peru. Sir G. Baker says that the drug was known in England about 1655. Among the champions of the administration of Cinchona infusion for intermittent fever was Robert Talbor who was later appointed physician to King Charles II in 1678 and knighted the same year. He had the good fortune to cure Dauphin of France of an attack of fever and thus became a favourite of Louis XIV to whom he sold his prescription which was later published. The demand for Cinchona bark was increasing to such an extent specially from India that Dr. Royle, Botanist to the Indian Government, fearing that the supply might run short recommended to Government in 1852 that the cultivation of Cinchona should be undertaken in the country. Mr. C. R. Markham was commissioned to organize an expedition to the forests of the Andes for collecting seeds and plants of Cinchona, Mr. Pritchett to explore Central Peru and Messrs. Spruce and R. Cross to Ecuador. Markham's collection of *C. Calisaya* died on the way to India while Mr. Pritchett's seed arrived in India in 1861 while others followed later. The same year Cinchona was introduced to Ceylon.

Composition. Cinchona contains a large number of alkaloids in varying proportions. Of these the most important ones are quinine, cinchonidine, cinchonine and quinidine.

Uses. Quinine is isolated from the total alkaloids of the bark as quinine sulphate which is a white odourless intensely bitter powder which is used for treatment of malarial fevers.

Cinnamomum—Cinnamon

Cinnamon consists of the dried inner bark of two-year old shoots of coppiced trees of *Cinnamomum zeylanicum* Nees. (S. Kurundu ; T. Kuruva, Ilayangam ; Skt. Tamalapatra) an evergreen tree usually attaining a height of 20 to 25 feet belonging to the family Lauraceae. It is indigenous to Ceylon and also occurs in the coastal regions of Western India up to an elevation of about 6000 feet above sea level.

The leaves are long, shining on the upper surface and leathery when mature and have a spicy odour when crushed. The flowers have a disagreeable smell while the fruit is a dark purple one-seeded berry. Several varieties of this are recognised among the inhabitants of the island based on the characteristic of the bark and taste. They are referred to as *Kahata—*, *Veli—*, *Sevel—*, *Pat—*, *Panni-miris—*, and *Naga-kurundu* of which *Pat-kurundu* is the cultivated form. It is also referred to as *Peni-rasse-kurundu* or *Ma-pat-kurundu.*

History. Cinnamon was one of the earliest spices known and it was often confused with *Cassia* bark in the early writings. Both were regarded as the

most costly of the aromatics, for among the offerings of vessels of gold and silver made by Seleucus II, king of Syria and his brother Antiochus Hierax to the temple of Apollo at Miletus 246 to 227 B.C. there were two pounds of *Cassia* and the same quantity of *Cinnamon*.

It is remarkable that none of the cinnamon of the ancients do not appear to have been obtained from Ceylon. Dioscorides and Ptolemy were of opinion that Cinnamon came from Arabia and E. Africa but this is doubtful since none of these countries produce any Cinnamon. It is probable that they imported the Cassia bark from China and called it cinnamon.

There is no evidence to show that cinnamon was produced in Ceylon earlier than 13th century. John of Montecorvino, a missionary who visited India mentions in a letter written between 1292 and 1293 of a tree like the laurel whose bark is exported from the island which is near Malabar. Cinnamon came into prominence with the discovery of Ceylon by the Portuguese in 1505. They occupied the island for the sake of Cinnamon 31 years later and the bark was collected from trees growing wild in the forests in the interior of Ceylon. About 1770 De Koke conceived the idea of cultivating Cinnamon on a commercial basis and this project was carried out with great success so that the Dutch who occupied the island after the Portugese were able to supply the entire European demand independent of the tribute of the bark from the King of Kandy.

After the English wrested the island from the Dutch in 1796 the Cinnamon trade became the monopoly of the English East India Company.

Composition. Cinnamon bark contains 0.5 to 1.0 per cent. oil which is light yellow in colour changing to red with age. The oil contains cinnamaldehyde, eugenol, benzaldehyde, methyl amyl ketone, phellandrene, pinene, cymene, nonyl aldehyde, caryophyllene and esters of isobutyric acid while the residue consists of tannin and mucilage.

Uses. Cinnamon bark with its agreeable odour and taste is well known as a culinary spice. Medicinally the bark and oil are used for their carminative and antiseptic properties. Commercially it is extensively used for flavouring confectionary, liqueurs, soaps and dental preparations.

Cocaina—Cocaine

Cocaine is an alkaloid occurring in the leaves of the coca shrub, *Erythroxylon coca* Lam., a much branched shrub of about 5 to 6 feet in height belonging to the family Erythroxylaceae. Its leaves are medium sized, obovate tapering to the base. The midrib and the two lateral veins in the leaf, very prominent on the lower surface, seem to be a characteristic feature of this genus. The younger leaves are yellowish green while the older ones are darker green on the upper surface and lighter below. The stipules are intrapetiolar, imbricating on the short arrested leafless branches. Flowers are small white, two or more flowers arising from an axil of a leaf. Fruit is a small ovoid one-seeded drupe.

The plant has been in cultivation for long in Peru and Bolivia and now in Java and Formosa. It is a plant prohibited by the Department of Excise to be cultivated in Ceylon.

History. There is no record of this drug been in use at any time in history but the inhabitants of Peru and Bolivia have been in the habit of using the dried leaf along with lime as a nerve-stimulant from time immemorial.

Composition. The extract of coca leaves contains a large number of alkaloids of which Cocaine (Methylbenzoylecgonine) is the most important and this is separated and purified into colourless and odourless crystals having a bitter taste followed by a sensation of tingling and numbness.

Uses. Cocaine is a very efficient surface anaesthetic as it is readily absorbed through the mucous membranes and raw surfaces. Solutions of cocaine hydrochloride are used as injections for extraction of teeth and applied locally for minor surgical operations. It is much used in ophthalmic surgery. The coca leaf is chewed by Indians as it imparts unusual powers of endurance allaying cravings of hunger and feeling of fatigue. It is a habit forming drug like opium and the addict has an intolerable craving for it.

Colocynthis—Colcynth

This consists of the dried pulp of the fruit of *Citrullus colocynthis* Schrad (E. Colocynth ; S. Yak-komadu ; T. Peykkomaddi; Skt. Mahendravaruni) a perennial prostrate or climbing herb belonging to the family Cucurbitaceae. The stem of this plant is long and slender, scabrous or sometimes hairy. The leaves are variable, deltoid in outline, deeply trifid, each lobe deeply pinnatifid and dentate, glabrous above and covered with prickly bristles beneath including the petiole. It bears pale yellow male and female flowers distinctive of the family. Fruit is globular 2 to 3 inches in diameter, smooth dark green mottled with 10 lines of paler irregular spots. The pericarp of the fruit is thin and it envelops a white, spongy pulp divided into 6 sections by spurious partitions. The plant is widely distributed throughout North Africa, Syria, Persia, Pakistan and cultivated in Spain and Cyprus. It is rare in Ceylon confined to the sandy wastes of Batticaloa, Puttalam and Jaffna.

History. Colocynth was known to the Greek, Roman and Arabian physicians of old. The drug was collected from Spain at an early period and the plant has been long in cultivation in Cyprus, mention of which has been made in 14th century.

Composition. The drug contains a bitter amorphous alkaloid and a resin in addition to a glycocide, α—elaterin, citrullol, hentriacontane, a phytosterol and a mixture of fatty acids.

Uses. It is a powerful hydragogue cathartic rarely used alone on account of its powerful action.

References

ALLPORT, N. L.—*The Chemistry and Pharmacy of Vegetable Drugs*, 1943.

ATTYGALLE, J.—*Sinhalese Materia Medica*, 1917.

BAILY, L. H.—*Standard Cyclopedia of Horticulture* Vol. I—1933.

The British Pharmaceutical Codex, 1934, 1949 *and supplement* 1952.

CHANDRASENA, J. P. C.—*The Chemistry and Pharmacology of Ceylon and Indian Medicinal Plants*, 1935.

DASTUR, J. F.—*Medicinal Plants of India and Pakistan*, 1953.

DYMOCK, W.—*Pharmacographia India* Vol. I-III, 1893.

DYMOCK, W.—*The Vegetable Materia Medica of Western India*, 1885.

FLUCKIGER, G. A. and HANBURY, D.—*Pharmacographia*, 1874.

GILDEMEISTER, E. and FR. HOFFMAN—*The Volatile Oils*; translation by Edward Kremers, 1900.

GREENISH, H. G.—*Pharmacognosy*—sixth edition, 1933.

GUNAWARDANA, G. W. GABRIEL—*Medicinal Plants of Ceylon and Sinhalese Medicines in English*, 1917.

HENRY, T. A.—*The Plant Alkaloids*, 1933 and 1949.

LEWIS, F.—*The Vegetable Products of Ceylon*, 134.

MAC NAIR, J.P.—Spices and Condiments Leaflet No. 15—*Field Museum of Natural History, Department of Botany, Chicago*, 1930.

PARSONS, T. H.—A list of Medicinal Herbs, Indigenous and Exotic that can be cultivated in Ceylon—*Bulletin No. 91, Department of Agriculture Ceylon*, 1937.

TRIMEN, H.—*A Hand-book of the Flora of Ceylon* (Parts 1-6) 1893-1931.

WATT, G.—*Dictionary of Economic Products of India.*

Wealth of India (Raw materials) Vol. I and II, 1948.

Improved Methods of Producing Cane and Palm Jaggery

C. CHARAVANAPAVAN

JAGGERY is produced in Ceylon from sugar cane, kitul and palmyra palms. The quality of these products, however, is variable and leaves room for much improvement. The problems connected with the production of high quality jaggery have been studied by the writer and the following improved methods have been found to be suitable.

Cane Jaggery

Cane Juice. Cane jaggery is prepared from sugar cane juice obtained by crushing the cane with special type of mills. The juice so obtained, contains many impurities in addition to the sugar present in it. On the average about 50 per cent. by weight of juice can be extracted from the cane. Fresh cane juice contains about 14 per cent. to 18 per cent. of sugar of which a small fraction is in the form of reducing sugars. The reducing sugar is mainly in the form of glucose.

Sugar cane juice of good quality, when extracted at the correct stage of maturity, contains less than 1 per cent. of reducing sugars. But, if the cane is undermature or overmature, the total reducing sugars would be above 1 per cent. High reducing sugar content in the juice would result in poor quality jaggery (1). The jaggery would be soft and moist.

Cane juice being slightly acidic, a certain amount of inversion would take place with the formation of glucose and fructose. This is prevented by liming the juice as soon as it is extracted. The juice should be strained through a fine mesh sieve to remove particles of fibre and so on, before liming.

The lime is prepared by adding 1 pound of well burnt powdered coral or dolomitic lime to a gallon of water and leaving it overnight. The mixture is well stirred and strained through a fine mesh sieve to remove particles of sand and grit. The milk of lime so obtained is added gradually in small quantities to the juice and stirred until red litmus turns slightly blue. The *p*H of the juice after liming should be between 7.5 and 8.0. Excess of lime should be avoided as this would result in a dark coloured product (2).

Preparation of Cane Jaggery. The limed cane juice is heated slowly in a suitable vessel to cause the calcium salts formed to coagulate with the impurities present in the juice. If satisfactory coagulation and clarification does not take place, a clear extract of superphosphate is added in small quantities at a time and stirred slowly while heating, until coagulation and clarification takes place. This extract is prepared by boiling 6 to 8 ounces of superphosphate in a gallon of water and leaving it overnight. The clear solution is decanted and used. Care should be taken not to add an excess of this extract, but a sufficient quantity is added until litmus paper just begins to lose its

blue colour but does not become red. The *p*H at this stage should be about 6.4. If superphosphate is not available, an extract obtained by crushing (*Hibiscus esculentus*) plants (lady finger) can be added little by little to the juice and stirred gently while heating until coagulation and clarification takes place. The extract is prepared by mixing 1 pound of crushed plants with one gallon of water and leaving it overnight. The extract is obtained by squeezing the mixture through a muslin cloth.

The coagulated juice is then heated without stirring until the impurities form a thick scum on the surface. The scum is quickly removed by means of a perforated ladle before the juice begins to boil. Any further quantities of scum formed on boiling, will collect near the sides of the vessel and are removed carefully. The clarified juice is then boiled down to a strength of about 70 per cent. total solids or 70° Brix, when it becomes a thick syrup. Finally the syrup is heated gently with constant stirring to prevent caramelisation. The striking point is reached at a temperature of 118°C to 120°C at sea level. The product becomes viscous at this stage. A few drops when introduced into a vessel containing cold water would settle down and harden without dissolving. The vessel is removed from the fire and the product is stirred until it cools sufficiently and shows signs of crystallization. Then it is poured into moulds to set. A yield of 1½ to 1¾ pounds of jaggery can be produced from a gallon of cane juice. The jaggery should be light brown in colour and hard.

Storage. Experiments conducted by the writer have shown that jaggery of good quality containing less than 8 per cent. of total reducing sugars does not become moist and deliquescent at ordinary atmospheric humidities of 70 per cent. to 80 per cent. However, during rainy weather when the humidity can go above 90 per cent. there is a tendency for even the best-quality jaggery to absorb moisture (3). It is therefore advisable to pack the jaggery in wooden boxes lined with well dried straw or plantain leaves and paper. Jaggery can be stored in small quantities in clean dry airtight bottles or tins.

Kitul Jaggery

Tapping of Kitul. Kitul jaggery is prepared from the juice obtained from the spathe of the kitul palm (*Caryota urens*). There are a number of methods of tapping the spathe which appears on the average about once an year. These methods were investigated by the writer and the following method is recommended :—

The second spathe that appears on the palm and the succeeding ones up to about the fifth are suitable for tapping. The spathe should reach the stage when the inflorescence is about to emerge. The inflorescence is exposed by removing the sheath covering it. On the seventh day after this treatment, a cavity is made at a distance of about 4 inches from the axil at the lower portion of the spathe. The size of the cavity is about 2 inches long by 1 inch wide by about 1 inch deep. The cavity is made to extend about half an inch into the core of the spathe on either side lengthwise. Into this cavity is introduced a mixture of spices, e.g., chillies, pepper, garlic, cinnamon, ginger and the leaves and bark of (*Croton lacciferus*), S. Keppetiya. This mixture is well pounded and treated with coconut

husk ash, salt and the juice of (*Citrus histris*), S. Lima. The cavity is then closed with the fluff adhering to the spathe and sealed with a piece of the sheath. This portion is then tied firmly with thin coir rope. Three days after this treatment, one third of the total length of the exposed portion of the inflorescence is cut off. The rest of the inflorescence is tied together by means of thin coir rope. The spathe is then trained to bend downwards by hanging a stone from it at a convenient point, after securing the spathe to a leaf above, by means of a rope. The tip of the spathe is then trimmed by cutting a thin slice off from the apex with a sharp knife. This is repeated every morning and evening until the sap begins to flow. A pot is then tied to the end of the spathe and the sweet toddy is collected. The trimming operation is carried out regularly every morning and evening after the sweet toddy is removed.

On the average, a spathe can give as much as one gallon of sweet toddy in the morning and about four bottles in the evening. The yield increases to a maximum and then begins to decline towards the end of the life-time of the spathe. The spathe becomes shorter and shorter as time goes by, as a result of the trimming operations. The spathe normally yields sweet toddy over a period of about 4 to 6 months.

Preservation of Kitul Sweet Toddy. The fresh sap from the spathe contains about 12 per cent. to 14 per cent. of sucrose. It does not contain any reducing sugars. But, as a result of the action of wild yeasts, moulds and bacteria, a certain amount of inversion of the sucrose takes place during the period of collection of the sweet toddy. The amount of invert sugar produced may exceed 1 per cent. which is detrimental to the production of superior quality jaggery. It is the common practice to use the leaves of (*Cyminosma pedunculata*), S. Ankenda, or the bark of (*Vateria accuminata*), S. Hal, to prevent inversion. Experiments conducted by Joachim and Kandiah (4) and the writer have proved that the former treatment is not effective though it causes a certain amount of clarification. The latter treatment was found by the writer to prevent inversion to some extent. However, both treatments were found to be unreliable. The only treatment that has been found to be feasible and effective was liming of the pots in which the sap is collected (4).

The following method of liming has been found by the writer to be satisfactory :—

A paste is prepared with about half an ounce of well burnt, powdered, coral or dolomitic lime with sufficient water. The paste is applied evenly to the inside of a clean, dry pot, of capacity to hold about one gallon of sweet toddy. The pot is dried in the sun or over a warm hearth and then tied to the spathe. The sweet toddy collected in the limed pot should have a *p*H of about 7.7 to 8.0 and should turn red litmus to a faint blue colour. Excess of lime should be avoided.

Preparation of Kitul Jaggery. The sweet toddy from the limed pot is decanted from any sediments and strained through muslin cloth to remove particles of fibre, etc. The product is then converted into jaggery in the same manner as described under cane jaggery.

It is not necessary to use superphosphate or lady finger plant extract for purposes of clarification as kitul sap contains sufficient phosphates to cause precipitation of the lime as calcium phosphate.

A gallon of sweet toddy gives on the average 1½ pounds of jaggery. Kitul jaggery if well prepared, is light brown in colour and quite hard and brittle. It has a pleasant flavour.

Storage. Kitul jaggery can be stored in the same manner as described under cane jaggery.

Palmyra Jaggery

Tapping of Palmyra. Palmyra jaggery is prepared from the juice obtained from the spathe of the palmyrah palm (*Borassus flabellifer*). Both male and female trees are tapped for their juice (5).

The male tree produces a number of inflorescences in one season. The male inflorescence consists of a number of branches very much like fingers. The spathe is ready for tapping when these fingers just begin to emerge. The external sheaths enclosing the spathe are removed and its finger-like branches are bandaged together, with strips of the tender palmyra leaves. After two days, one-third of the total length of the spathe is cut off from the apex. The next day a small pot is attached to the end of the spathe to receive the exuding juice. Thereafter, a thin slice is cut off from the tip with a sharp knife, every morning and evening after the sweet toddy is removed.

On the average, a male spathe can give about ¾ bottle sweet toddy in the morning and about ½ bottle in the evening. The yield increases to a maximum and then begins to decline towards the end of the life-time of the spathe. The male spathe can yield sweet toddy for about 1½ to 2 months. About two male spathes can be tapped per tree per season.

The female tree also produces a number of inflorescences. The female inflorescence is ready for tapping when the young fruits are just forming. The spathe is beaten lightly with a small iron hammer for a few minutes on the first day. This causes bruising and relaxation of the tissues. This operation is repeated after an interval of two nights. The first incision is made after another two days and the pot is hung as usual. Then the slicing operations are continued every morning and evening after the sweet toddy is collected.

On the average a female spathe can give about one bottle of sweet toddy in the morning and about ¾ bottle in the evening. The female spathe can yield sweet toddy for about 2 to 3 months. About 3 spathes can be tapped per tree per season.

Preservation of Palmyra Sweet Toddy. The fresh sap from the palmyra spathe contains about 8 per cent. to 10 per cent. of sucrose and no reducing sugars. As in the case of kitul sweet toddy, lime is used to prevent inversion. About one-eighth of an ounce of well burnt, powdered, coral or dolomitic lime is mixed with sufficient water to form a paste. This paste is applied to the inside of a clean dry pot of capacity to hold 2 bottles. The pot is allowed to dry in the sun or over a warm hearth and then tied to the spathe. Excess of lime should be avoided.

Preparation of Palmyra Jaggery. The same procedure is adopted as in the case of kitul jaggery. A gallon of palmyra sweet toddy gives on the average about 1 pound of jaggery.

Palmyra jaggery when well prepared is light brown in colour and quite hard and brittle. It has an agreeable flavour.

Storage. Palmyra jaggery can be stored in the same manner as described under cane jaggery.

Acknowledgments

Thanks are due to Mr. H. Reerink, the F. A. O. Sugar Cane Agronomist, for information relating to sugar cane varieties.

I am grateful to Mr. D. M. A. Jayaweera, the Superintendent, Botanic Gardens, for affording me facilities to conduct a kitul tapping experiment at the Royal Botanic Gardens, Peradeniya.

I have also to thank Mr. S. Sithamparapillai of the Propaganda Division for particulars regarding the palmyra palm.

References

(1) LAKSHMANA RAO, T.—Jaggery making in Hospet and suggestions for its improvement.—*Madras Agricultural Journal,* 1928, Vol. XVI, P. 414.

(2) ANNET, H. E. et al.—Experiments on the Improvement of the Date Palm Sugar Industry in Bengal.—*Memoirs, Department of Agriculture, India, Chemical Series,* 1916, Vol. V, No. 1, P. 69.

(3) VARAHALU, T.—Studies in Sugar Cane Jaggery IV.—Some properties of jaggery in relation to moisture.—*Madras Agricultural Journal,* 1938, Vol. XXVI, P. 55.

(4) JOACHIM, A. W. R. and KANDIAH, S.—Investigations on the keeping quality and storage of Kitul (*Caryota urens*).

Jaggery and Treacle—*Tropical Agriculturist,* 1939, Vol. XCII, P. 73.

(5) AUBERT, L.—The manufacture of Palm Sugar in Upper Burma—*The Agricultural Journal of India,* 1911, Vol. VI, P. 369.

The Relation between Body Dimensions and Body Weight in Sinhala Cattle

F. I. BAGOT

Introduction

WITH the introduction of the bull calf exchange scheme initiated by the Department of Agriculture, it became necessary to evolve a practical and ready means of estimating weights of cattle where there is no access to scales. It was found that the results of past investigations on the use of body measurements for estimating weight could not be satisfactorily applied to local cattle owing to the inherent peculiarities in the conformation of these animals. The present investigation was therefore devoted to a study of the inter-relationships between different body measurements and weight in Sinhala cattle, with a view to arriving at a basis for estimating weight.

Material and Methods

The data for this study were obtained from 336 Sinhala animals that were stationed on three Government Farms, Karagoda-Uyangoda, Ridiyagama and Nikaweratiya. Heart girth, length and weight records of each animal were used in the analyses. Heart girth was obtained by placing the tape around the animal just behind the forelegs tight enough to ensure an accurate reading without indenting the flesh. Body length was measured as the distance from point of shoulder to pin bone. Platform scales were used in recording the actual weights of the animals.

For the purpose of analysis the raw data were first grouped into five weight ranges (0-100 lb.; 101-200 lb.; 201-300 lb.; 301-400 lb.; over 400 lb.) and the correlations between the body measurements and weight were calculated separately within each weight range. The linear regressions of weight on heart girth and the multiple regression of weight on heart girth and length were also calculated within each group. But, since the group averages and their corresponding standard deviations tended to be proportional, it was decided to transform all the measurements and weights to logarithms for the final analysis. The transformed data were then employed to calculate the correlations between different body dimensions and body weight and their corresponding regressions.

Results

Correlation coefficients calculated on the entire data before transforming to the logarithmic scale showed highly significant relationships between body dimensions and body weight. The correlation between heart girth and weight was 0.971 ± 0.003 and that between length and weight was 0.960 ± 0.004. These results for Sinhala cattle are in close agreement with the relationships reported by investigators for other breeds (1).

Within each weight range (0-100 lb.; 101-200 lb.; 201-300 lb.; 301-400 lb.; and over 400 lb.), it was found that the

linear regression equations based on weight and heart girth gave almost as good estimates of weight as the multiple regression equations involving weight, heart girth and length. The errors of estimate were nearly of the same order in the two cases, and it was therefore concluded that for most practical purposes heart girth measurements alone may be satisfactorily employed in estimating weight.

The correlation between log heart girth and log weight was 0.994 based on 336 animals with a weight range from 35 lb. to 711 lb. The regression equation, in logarithms, for estimating weight (Y) from heart girth measurements (X) was found to be $Y = 3.0745 X—2.6839$.

Using this equation, the estimated weights for various heart girth measurements were calculated. These results are set out in Table 1.

Table 1.—Estimated Weights for various Heart Girth measurements of Sinhala Cattle

Heart Girth Inches	*Weight Pounds*	*Heart Girth Inches*	*Weight Pounds*	*Heart Girth Inches*	*Weight Pounds*
22	28	36	126	50	347
23	32	37	137	51	368
24	36	38	149	52	391
25	41	39	161	53	415
26	46	40	175	54	439
27	52	41	188	55	465
28	58	42	203	56	491
29	65	43	218	57	518
30	72	44	234	58	547
31	80	45	251	59	576
32	88	46	268	60	607
33	97	47	286	61	638
34	106	48	305	62	671
35	116	49	326	—	—

Summary

A study has been made of the relationship between body dimensions and body weight in Sinhala cattle for the purpose of estimating the latter from the former where there is no access to scales.

The correlations between length and weight, heart girth and weight and log heart girth and log weight were found to 0.960, 0.971 and 0.994 respectively.

A regression equation, in logarithms, for estimating weight from heart girth measurements has been calculated and the estimated weights corresponding to different heart girth measurements have been tabulated.

Acknowledgment

Sincere thanks are due to Dr. P. Mahadevan for his guidance in the preparation of this paper.

Reference

(1) WANDERSTOCK J. J. and G. W. SALISBURY, 1946.—The relation of certain objective measurements to weights of beef cattle—*Jour. An. Sc.*, 5 : 264-271.

Two Methods of Constructing a Cattle Stop

C. R. KARUNARATNE

CATTLE stops are structures constructed at entrances to farms or at entrances to cattle paddocks to prevent cattle trespass. These are very popular in New Zealand and in Australia particularly in Queensland where stock raising is done extensively. One of the main advantages of cattle stops is that gates can be dispensed with and the necessity to shut or open gates every time one enters or leaves a farm does not arise.

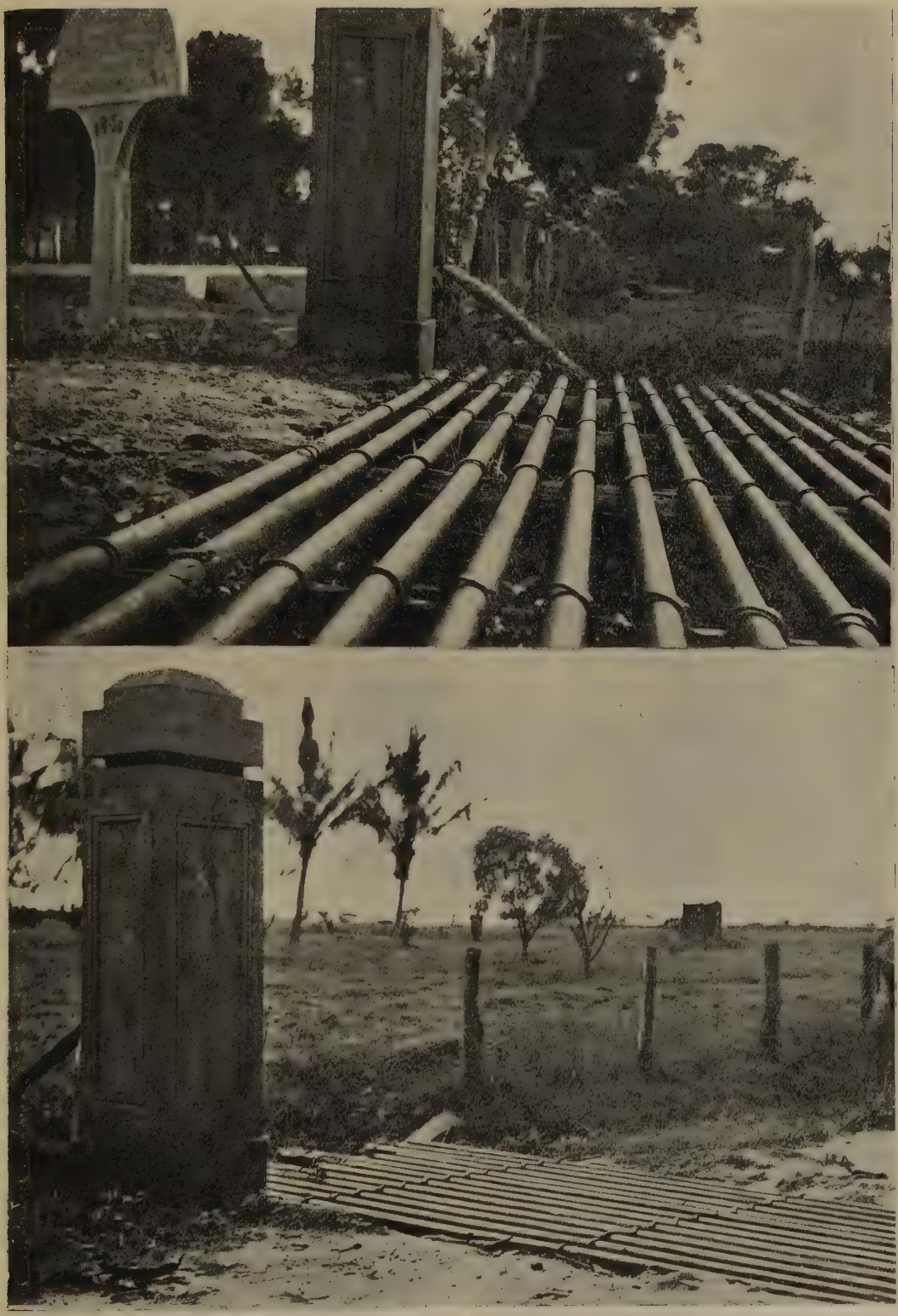
Construction of a cattle stop is comparatively simple. A pit has to be dug, about 5 to 6 feet wide, 8 to 10 feet long and 1½ to 2 feet deep at the entrance to a farm, or at any spot where the cattle stop is required. When the cattle stop has to be constructed at the entrance to a farm it would be advisable to locate the pit in relation to the drain from the main road. A short concrete or rubble wall is constructed along the length of each side of the pit and strong wooden cross supports, wedge shaped at the top and spaced about four feet apart, are laid across the pits. The two ends of the cross supports are securely embedded in the wall.

Galvanized or black iron pipes 2½″ to 3″ in diameter are then laid across the supports spaced 4″ to 6″ apart. The pipes can be seated securely by cutting grooves in the cross supports. The pipes are securely bolted on to the cross supports, thus covering the entire pit. It would be very advisable to introduce a rubber pad, cut from a discarded motor-car tyre in each groove in the cross supports to cushion shock when traffic passes over. When piping is not available palu rafters, 5″ × 2″, rounded at the top, may be used. The barbed wire fence extended to the two sides across the pit completes the stop.

Cattle stops can also be constructed out of railway irons set on concrete in such a manner that the irons can be moved. About eleven railway irons, each ten feet long, spaced on 7-foot centres, will give about 4½″ spacing between the irons at the top. These irons can be assembled in three units, two outside units, each of three irons, and the central unit of five irons. The irons in each unit are bolted together, six inches from each, and with ¾″ diameter bolts. These pass through short pieces of ¾″ piping which act as spacers. The two outside units are bolted to the centre unit of five rails with short bolts through spacer piping. The eleven rails then form one rigid unit.

The advantage of having the rails in three units is to facilitate cleaning the cattle stop when required. Only one section has to be lifted for purposes of cleaning.

The railway irons are supported at each side by a nine-inch thick concrete wall. The rails rest on a four-inch wide and deep step in the concrete. A space of about three-quarter inch is left for play between the ends of the rails and the side of the concrete wall.



Two aspects of a cattle stop constructed at the entrance to a farm, using galvanized iron pipes and wooden supports.

Strips of rubber, from discarded motor car tyres, may be placed between the railway irons and the concrete to cushion shock when traffic passes over. This type of cattle stop is neat and does not rattle or bump when vehicles are driven over.

Four cattle stops constructed with galvanized piping at Kurundankulama and Relapanawa Dry Farming Schemes have proved very effective against roaming herds of stray cattle that abound in the North-Central Province. (See photographs on page 125.)

When a bullock cart has to be driven over a cattle stop it will be necessary to lay across the stop two wooden planks, preferably about 18″ to 2 feet wide, joined together by battens, for the pair of bullocks to walk on. These planks should be removed immediately the cart passes over lest stray cattle enter.

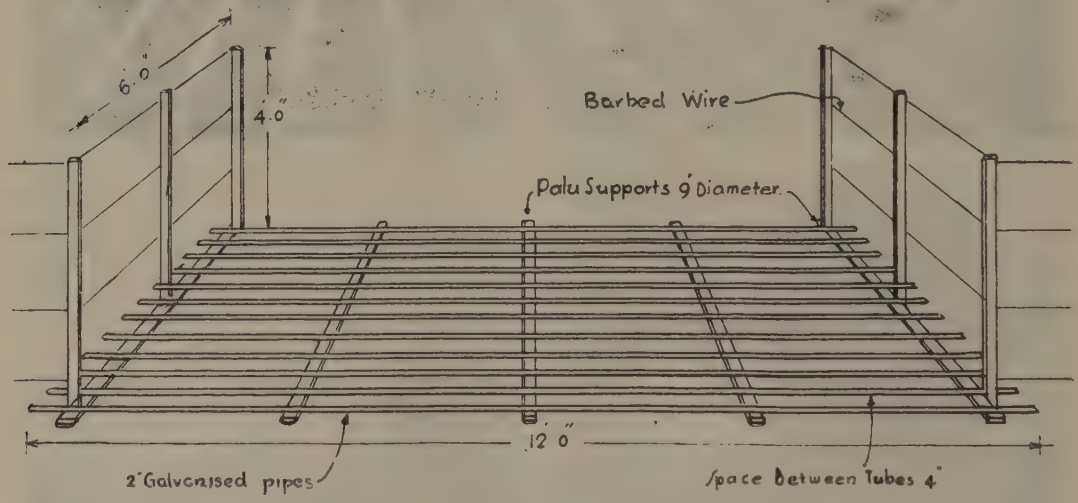


Diagram showing how to construct a simple and effective cattle stop

RESEARCH NOTES

Repeatability and Heritability of Milk Yield in Crosses between Indian and European Breeds of Dairy Cattle

THE concepts of repeatability and heritability are associated with the relative importance of heredity and environment in influencing the variations in a character. A knowledge of the repeatability and heritability of a characteristic is very helpful in determining the method of selection to be adopted, in choosing an efficient breeding system, and in estimating genetic gains.

Repeatability may be defined as the fraction of the variance that is attributable to permanent differences between individuals. It includes the additive genetic variance and also the variance due to dominance deviations, epistatic deviations, and the effects of environment that are permanent for each animal but differ from one animal to another. Heritability, on the other hand, is defined as the fraction of the variance that is attributable to the average effects of genes. Since some of the permanent differences between individuals may be non-transmissible, heritability will generally not be as great as the repeatability.

A fair number of investigations have been made in recent years to determine the repeatability and heritability of milk yield in different cattle populations in temperate countries. But corresponding studies in the tropics and sub-tropics are practically non-existent. The present analysis, based on data compiled by the Animal Husbandry Bureau of the Imperial Council of Agricultural Research and published in 1941, was therefore undertaken in an attempt to provide some estimates of the repeatability and heritability of milk yield in crosses between Indian and European breeds of dairy cattle in India.

Repeatability among ¼, ½, 5/8 and ¾ crossbreds was computed as the within-herd correlation between different records of the same cow. It was found on the basis of the first four lactation records of each cow that the average repeatability of milk yield in the four groups was 0.58, 0.55, 0.65 and 0.4 respectively. The overall average irrespective of fraction of European blood worked out at 0.53 for over 3,000 lactation records. In other words, of the total variation in milk yields within herds, 53 per cent. is between cows and the remaining 47 per cent. is between lactation of the same cow.

Heritability was estimated by intra-sire daughter-dam regressions using the highest yield of the dam and the highest available yield of the daughter without correction for age. Unfortunately, the data were classified only on the breeding of the daughters and an adequate analysis could not be carried out in the separate groups. The average heritability, irrespective of the fraction of European blood, was found to be 0.19 on the basis of 1,102 daughter-dam pairs.

Any estimate of repeatability or heritability is strictly applicable only to the data from which it is calculated, since such estimates describe a condition prevailing in a population at a given time, and they apply primarily to variance in performance of individual animals.

In the present study, the repeatability seems to be slightly higher and the heritability slightly lower then the estimates reported from cattle populations in temperate countries. With repeatability as high as obtained here, the very low producers can be culled as soon as their first lactation records are available with no great risk of culling good cows. The rather low heritability on the other hand, may indicate that only a small fraction of the phenotypic superiority of the individuals selected as parents is transmitted to the next generation. But the estimate of heritability presented here suffers from the drawback that it was not possible to standardize the yield figures for environmental influences such as season of calving, age, etc., before using them for the regression analysis. The true value of heritability in the population may therefore be slightly higher than this estimate.

The results, as they are, indicate that only about one-fifth of all the differences or roughly one-third of the permanent differences between the milk yields of crossbred cows in India are transmissible. The remaining variation is due to intangible differences caused by temporary and permanent environmental factors.

P. MAHADEVAN

APPRECIATIONS

GODFREY HARBORD

Godfrey Harbord, Dip. Agric. (Wye), was born on September 26, 1887, and died after a short illness at the Nursing Home, Kandy, on April 26, 1954.

Harbord joined the Department of Agriculture on February 21, 1910, as Superintendent, Experiment Station, Maha Illuppallama, and served in various capacities thereafter. From October 1915 to July 1919 he was on active service in the Army during World War I. After his return to the Island he was posted to different stations in the Department, but for the greater part of the period between then and his retirement, his work was in the dry zone. He filled the capacities of Manager, Experiment Station, Peradeniya, Divisional Agricultural Officer, Central, Southern and Northern, with equal acceptance. His experience as an administrative Agricultural Officer was, therefore, extremely wide and his knowledge of tropical agriculture in its practical aspects, considerable. His work on cotton, sisal, tobacco and other dry zone crops has provided us with very useful information on these crops. He initiated the Kurundankulama Dry Farming Scheme and was largely responsible for organizing the early cotton purchase schemes in the Hambantota District. Harbord was responsible for the start of many new agricultural stations in the Island, notable amongst them being the Hingurakgoda Farm.

Harbord retired from the Department in September, 1942, after a period of 32 years' service, but his practical knowledge and experience of Ceylon crops was not lost to the country thereafter for he devoted many years of his retired life to work on the plantation crops.

Harbord was a silent but steady worker. He did not flinch from undertaking any task assigned to him however difficult it was, and, having done so, did not seek for himself publicity for its accomplishment. His health had suffered as a result of his war service and though this was a handicap during the last years of his official life and thereafter, he carried on with fortitude and courage to the end.

A. W. R. J.

DR. W. SMALL

Dr. W. Small, M.B.E., M.A., B.Sc., Ph.D. (St. And.) F.L.S., died on November 10, 1953, at the age of 68 at his home in Fifeshire, Scotland, when in retirement following an abdominal operation.

Small was appointed Botanist, Department of Agriculture, Uganda, on February 5, 1913. On April 1, 1930, he was made Mycologist of the same Department. On February 23, 1926, he was transferred to Ceylon and appointed Mycologist of this Department in place of T. Petch who had retired from Government Service in 1925. Soon after assuming duties he became interested in the fungus *Rhizoctonia bataticola* which he found present in the roots of many woody plants often accompanied by one or more of the older better known fungi like *Fomes lignosus, Poria, Rosellinia, Ustulina,* etc. He put forward the view that root disease of the economic and other plants in Ceylon is due primarily to *R. bataticola* and suggested that the other fungi like *Fomes, Poria,* etc., were only of secondary account. This statement gave rise to much criticism and controversy, and it is unfortunate that he was unable during the short period he was in the Division to confirm by experiment the true status of the fungus, i.e., whether it is truly parasitic or secondary.

On the departure of F. A. Stockdale, Director of Agriculture, for England on November 21, 1928, Small was appointed to act as Director. He officiated in this capacity until March 17, 1930, and reverted to his office as Mycologist and left on May 24, on leave prior to transfer as Director of Agriculture, Nyasaland. During the period March 17 to May 23, he was occupied in work on the Report of the Committee on Soil Erosion of which Committee he was Chairman.

Quiet and unassuming, Small developed many friendships and associations. He was deeply interested in the welfare of his colleagues and subordinates and received in return their loyal support and co-operation.

L. S. B.

TOM PETCH, B.A., B.Sc. (Lond.)

Botanist and Mycologist, 1905-1925

Tom Petch, Botanist and Mycologist in the Department of Agriculture for 20 years, died at his home at North Wootton, King's Lynn, England, on December 24, 1948, at the age of 78. By his death Ceylon in particular and the tropical world in general have suffered a great loss in the field of Botany and, especially, Mycology.

Petch was appointed Mycologist to the Ceylon Government in 1905 and began the publication of a series of revisions of the fungi of Ceylon, which at the time was in a state of confusion. In 1912 when the Department of Agriculture superseded the Department of the Royal Botanic Gardens, Petch was appointed Botanist in addition to his duties as Mycologist.

It is difficult in a short article to enumerate the work he did in Ceylon. He dealt with the diseases of plantation crops—tea, rubber, cacao and coconut, and published three books which should find a place in the book shelves of every agricultural library and planter. In 1911 he published "The Physiology and Diseases of Hevea brasiliensis", in 1921 "Diseases and Pests of the Rubber Tree", and in 1923 "The Diseases of the Tea Bush".

Petch was a Botanist and a brilliant Mycologist. For many years he edited the "Annals of the Royal Botanic Gardens", Peradeniya, which contains numerous contributions from him. His publications "Revisions of Ceylon Fungi", "Additions to Ceylon Fungi" and "Studies in Entomogenous Fungi" which established his reputation as a world authority are legacies he has left behind, which should stir the younger generation of research workers in Ceylon to greater effort.

Petch was undoubtedly the world's foremost tropical Mycologist. He laid the foundations of Ceylon Mycology on a sound footing on which others could build. His last work "The Fungi of Ceylon", published with G. R. Bisby as Peradeniya Manual VI, will serve as a partial summary of his extensive and excellent work on the Fungi of Ceylon. He did not live to see the printed book, but saw the proof of the publication though he was unable to make the final corrections. Fortunately he had checked the manuscript and the typescript very carefully.

Petch retired from Government Service in 1925 and was invited to organize the Tea Research Institute of Ceylon of which he became the first Director. He laid the foundation of an excellent institute and returned home in 1928.

Petch was a man of a retiring disposition. His work was his hobby. He hated publicity. He spoke little and always to the point. As a superior he was very exacting and expected from his subordinates a high sense of duty. No matter how busy, he was always ready to place his experience and knowledge at the disposal of others. His obituarist having worked under him for twelve years feels that these were the happiest years of his career.

Petch, despite his great service to Ceylon sought no honours and no honours came his way. His name, with those of Thwaites, Trimen and Willis, will ever remain green. He has passed away but his work lives.

L. S. B.

CENTRAL BOARD OF AGRICULTURE

PROCEEDINGS OF THE SIXTH MEETING OF THE CENTRAL BOARD OF AGRICULTURE HELD AT THE SCHOOL OF AGRICULTURE, PERADENIYA, ON MAY 3, 1954

Dr. A. W. R. Joachim, Director of Agriculture, presided and the following were present :—

Mr. C. A. M. de Silva (Vice-Chairman) ; Mr. R. T. Chelliah ; Senator Justin Kotalawala ; Mr. Vernon Rajapakse ; Mr. T. B. Naranpanawa, D. R. O.; Dissawa T. B. Poholiadde, M.B.E.; Mr. Albert Godamunne ; Mr. S. L. Bandara Dharmakirti ; Mr. H. S. Wanasinghe, C.C.S., representing the Director of Land Development ; Mr. Gladwin Kotalawala, M.B.E.; Mr. N. Manicka Idaikkadar, C.C.S., Director, Food Production ; Mr. L. B. Rajakaruna, Deputy Commissioner of Marketing ; Major E. C. de Fonseka, M.B.E., E.D.; Mr. M. B. Samarakoon, D. R. O.; Mr. W. M. Cumaraswamy ; Sir James P. Obeysekera ; Mr. S. B. Yatawara, Deputy Commissioner of Co-operative Development ; Mr. S. A. Selvanayagam, O.B.E.; Mr. S. Sivapalan ; Mr. A. Perumynar, D. R. O.; Mr. A. M. Clement Dias; Mr. J. M. Sabaratnam, D. R. O.; Mr. S. Thondaman, M.P.; Mr. D. G. Dayaratna, C.C.S., Director of Rural Development ; Mr. A. D. Paranavitane ; Mudaliyar N. M. Abulcassim Maraikar ; Mr. Marcus Rockwood ; Mr. A. Hensman ; Mr. R. H. de Mel ; Gate Mudaliyar M. S. Kariapper, J.P., U.M.; Mr. R. H. Spencer Schrader, J.P., U.M.; Mr. F. C. Cooke, Director, Coconut Research Institute ; Mr. M. Atkinson ; Mr. C. Wijesinghe and Mr. A. J. Joseph, C.C.S., Assistant Director of Agriculture (Administration), Secretary.

The following visitors were also present :—

Mr. M. L. D. Caspersz, C.C.S., Commissioner of Food Supplies, and Prof. Evan. A. Hardy, F.A.O. Technical Assistance Mission.

The following officials of the Department were also present by invitation :—

Mr. C. N. E. J. de Mel, Deputy Director of Agriculture ; Dr. W. R. C. Paul, Assistant Director of Agriculture (Technical) ; Mr. A. V. Richards, Horticultural Officer ; Mr. G. V. Wickremesekera, Divisional Agricultural Officer, Central Division ; Mr. E. S. Jayasundera, Divisional Agricultural Officer, North-Western Division ; Mr. L. H. Fernando, Botanist, Mr. C. R. Karunaratne, Agricultural Officer (Dry Farming) ; Mr. Gratian de Silva, Assistant Agricultural Officer, Propaganda ; and Mr. J. E. Senaratne, Systematic Botanist.

Letters and telegrams regretting inability to attend the meeting were received from the following :—

Mr. R. Singleton Salmon, O.B.E., M.P.; Dr. H. E. Young, Director, Rubber Research Institute ; Sir Wilfred de Soysa ; Mr. S. Pararajasingham ; Mudaliyar M. M. Ibrahim, M.P.; Mr. G. K. Newton ; Mr. N. R. Rajavarothiam, M.P.; Mr. H. Abeywickrema ; Mr. N. H. Keerthiratne, M.P., Parliamentary Secretary ; Mr. L. S. Boys ; Mr. K. Morford, C.B.E., J.P.; Gate Mudaliyar N. Wickremaratne ; Mr. J. Lamb, Director, Tea Research Institute ; Senator Lady Molamure, O.B.E.; Mr. S. Pathmanathan ; Mr. F. A. Wickremasuriya ; Senator Miss Cissy Cooray ; Conservator of Forests ; Mr. Anton Ponnambalam ; Mr. S. Vytilingam, M.P.; and Mr. E. W. Kannangara, C.B.E.

I—Confirmation of the Minutes of the last Meeting

The minutes of the last meeting of the Central Board of Agriculture were unanimously confirmed.

Chairman—" Gentlemen, I am sorry that the meeting of the Board originally fixed for March 22 had to be postponed as Gate Mudaliyar Wickremaratne who was to take

a leading part in the meeting was unable to be present. Unfortunately it so happens that the Gate Mudaliyar is unable to be present at this meeting too as his doctors have advised him not to leave Colombo and so we are deprived of the benefit of his experience. He was the principal person to participate in the proceedings today. But any way I think as we have several members interested in this subject, Gate Mudaliyar Wickremaratne's paper could be discussed. We shall therefore deal with the items as indicated in the Agenda.

There is also one other matter to bring to your notice and that is, one of our members, Mr. G. K. Newton, is away in Europe on leave and wants the authority of the Board for his absence during that period. I take it that there is no objection."

II—Cultivation and Marketing of Vegetables

The item on the Agenda was the further consideration of the Report of the Sub-Committee on the "Cultivation and Marketing of Vegetables". Discussion to be initiated by Mr. L. H. Fernando, Acting Botanist.

Chairman—"Gentlemen, on this matter I would like to remind you that before this present Board came into operation or existence, we appointed a Sub-Committee consisting of members from the earlier Board to go into the question of vegetable production and marketing and this Sub-Committee furnished a report which unfortunately was not examined adequately. There was no time to do so. At one of our earlier meetings we decided to reconsider this matter and appointed another sub-committee to consider the various issues involved.

Mr. L. H. Fernando, Acting Botanist, was appointed convener of this Sub-Committee and perhaps he would like to make a statement on the present position."

Mr. S. Sivapalan—"Mr. Chairman and Gentlemen—You are aware, and the members are aware, that the functions of this Sub-Committee involve a lot of work such as collection of statistics, &c. I would therefore ask whether we could initiate a discussion on this subject at this stage when we have been able to hold only one meeting and we have had no opportunity to discuss this matter in detail. Therefore whether the Board would like to have a discussion on this subject at this juncture or at a later stage is for you to decide. I feel myself that we have been able to go into only 25 per cent. of what we should have done and therefore it would be appropriate if we could take up this question at the next Board meeting. After all we had no opportunity of meeting and discussing this matter fully."

Chairman—"I would like Mr. Fernando merely to state the present position. The Committee could not have a full discussion on this matter and I certainly do not have any objection at all to a full discussion on the subject being postponed for a later meeting when it could be fully considered by the Board in due course after the Committee conclude their deliberations."

Mr. L. H. Fernando, Acting Botanist—"Mr. Chairman and Gentlemen, at the last meeting of the Board you decided that the Sub-Committee on vegetable production and marketing should continue its deliberations until it was in a position to prepare a full report for consideration by this Board. You will remember that the interim report of this Sub-Committee gave information relating to the production of vegetables. At present the question of marketing is being discussed by this Sub-Committee and problems of storage, transport, processing and increased production and better distribution are being examined by the Committee. We have also got information on estimated production in the various revenue districts of the Island. These figures are now being used by the Sub-Committee but it has been possible for the Sub-Committee to meet only once so far and the second meeting has been arranged for May 24. I might explain here that it was not possible for all members of the Sub-Committee to meet, the Chairman in particular. At the last meeting held in Colombo I received a number of letters from members asking me to request the Chairman to put off the discussion. We have, therefore, had no time to discuss this matter in full and have the report ready for consideration. I believe after further discussion we will be able to have the final report for consideration by the Board."

Chairman—"Is there any objection to this matter being discussed by the Board when the Committee has finished its deliberation?"

The Board had no objection and the matter was put off for a future meeting.

III—Popular Names for Local Grasses

The item on the Agenda read as follows :—

"Discussion on popular names for local grasses—Discussion to be initiated by Dr. W. R. C. Paul, Assistant Director of Agriculture (Technical), Chairman of the Sub-Committee."

Chairman—"We appointed a Sub-Committee to go into the matter of popular names for grasses, both local and introduced. There was also a Departmental Pasture Research Committee which had made a special study of grasses and had a prior discussion on this subject. It had prepared a list of popular names for local and introduced grasses and legumes for consideration at the first meeting of the Sub-Committee."

Dr. W. R. C. Paul, Assistant Director of Agriculture (Technical)—"Mr. Chairman and Gentlemen—I regret it has not been possible for the Sub-Committee to hold more than one meeting and that too only this morning. I made several attempts to convene meetings both at Peradeniya and at Colombo but for one reason or other members could not find it convenient to be present. It was only possible so far to have a single meeting this morning.

This subject, as the Director has already explained to you, was discussed at one of the meetings of the Pasture Research Committee of the Department and a tentative list of names was prepared, cyclostyled and distributed to members of the Sub-Committee. This list was prepared in the first instance by Mr. J. E. Senaratne, Systematic Botanist, and the Pasture Committee examined it and made such amendments and alterations as were considered desirable. The list is not complete. It was not clear whether the list should include only the good grasses that are known in Ceylon, both introduced and indigenous, or both the grasses that are of value in pasture as well as those that are not. We therefore decided to make a list of a representative selection of all grasses and legumes—both good and poor. But the Sub-Committee was of opinion that it should be more comprehensive and should include all grasses whether weeds, inferior or good, local and imported grasses. Since we are dealing primarily with pastures and there is the possibility of weeds and inferior grasses invading those, the farmer should be able to refer to any of these, whether they are weeds or inferior grasses, by their popular or standard names.

This morning the Committee added a number of other Sinhalese and Tamil names to the list prepared by the Pasture Research Committee and which has now been passed to the members of the Board. I do not know whether you consider it necessary that I should go into detail giving the names of all the additions that have been suggested by the Committee this morning or whether I should prepare a fresh list to include all the amendments for issue later to the members of the Board.

I have also brought here a number of representative samples of grasses and legumes in case members of the Board are not familiar with either their Botanical or local names and would wish to know something about them. I should like to mention that in this list the pasture grass considered by the Department to be the most outstanding is number 4 on the list, viz., *Brachiaria brizantha* or Palisade signal-grass. This is our best pasture grass which we have recently introduced from East Africa (Uganda and Tanganika) and we have now more than 500 acres of it established on our Departmental stations. Signal-grass is the popular name used in America for all species of *Brachiaria*. That is because the inflorescence has a characteristic signal like appearance. In order to differentiate between the several species of *Brachiaria* we use the word Palisade which is the popular name for this grass in East Africa.

As regards legumes there has been some difficulty in finding popular names because the peasant in Ceylon does not appreciate the value of legumes in a pasture. The Committee has suggested a few additional names and these will be included in the list."

Senator Justin Kotalawala—"Dr. Paul mentioned that Palisade grass is the best. Could he tell us where it is grown, how it is grown, and give a description of it? I would also like him to mention something about Mimosa."

Dr. Paul—"*Brachiaria brizantha* is a grass that has come from East Africa and in a very short time it has proved to be a real winner. When established, it has even shown promise of suppressing weeds like illuk and couch. There are two strains of this grass, one from Tanganika which has a more erect habit and the other from Kenya. This grass although it flowers and seeds regularly does not produce viable seed. But, this is not a serious difficulty in the tropics. Cuttings from 12 to 36 inches are thrown into furrows created by ploughs and covered with soil by cross harrowing. In about two or three weeks the grass will sprout and in about two months time it is ready for grazing. It has proved to be the most drought-resistant grass that is so far known."

Senator Justin Kotalawala—"How does it affect coconut?"

Dr. Paul—"It can be grown successfully under coconut."

Senator Justin Kotalawala—"What is the protein content of this grass?"

Dr. Paul—"The protein content will vary according to the rate of grazing. If the grass is grazed at the correct stage the protein content is about 12 per cent."

Mr. Vernon Rajapakse—"With regard to manuring, do you advocate artificial or cattle manure?"

Dr. Paul—"Preferably cattle manure before planting and later regular applications of fertilizer. A considerable saving on concentrate feeds can be effected by applying fertilizers to the pastures which will be of higher nutritive value than the unmanured pastures."

Mr. J. M. Sabaratnam—"What is the fertilizer that you would recommend?"

Dr. Paul—"1 cwt. sulphate of ammonia, 2 cwt. of superphosphate and ½ cwt. of muriate of potash."

Mr. J. M. Sabaratnam—"Are we to take the paper issued by the Sub-Committee as its report? Before we proceed further, I would suggest that we refer this paper back to the Sub-Committee."

At this stage Dr. Paul explained that it was not the report of the Sub-Committee but a list prepared by the Pasture Research Committee and submitted to the Sub-Committee. This list had to be amended and a fresh list issued.

Mr. S. Sivapalan—"Chairman—Certain information has to be obtained from your Department to find out some details as to what is happening in other parts like India, and further Sub-Committee Meetings will have to be held before a report can be furnished. Dr. Paul has only been able to say today what we have been doing this morning. This has given us a basis for proceeding on the Sub-Committee's work and certain amendments have been made. These amendments need further clarification and further details have to be obtained, so that it will not be possible to issue a report at this moment."

Dr. Paul—"All I suggest is that if you desire it, I can re-issue this paper to include all the amendments that were suggested today by the Sub-Committee or if you consider it desirable the Sub-Committee can meet as a Standing Committee to consider new names and amendments as they become necessary.

As regards Senator Kotalawala's inquiry on *Mimosa*, a thornless strain of *Mimosa invisa* was discovered a few years ago in Java. I do not know whether members are aware that this species was introduced as a ground cover legume but it did not make much headway as a cover crop because of its thorny habit. The strain I now refer to is thornless and I obtained some seed from Indonesia. It proved to be completely thornless and a vigorous ground cover. I cannot yet say how drought-resistant it will be because trials are not yet complete. I also cannot say whether it will suffer from any disease or whether it will die back as in the case of most of the other cover crops

that have been tried in the past on rubber. It gives promise of being useful both as a cover as well as a forage crop."

Dr. Paul also showed a specimen of the grass called Weeping love-grass and continued to describe it: "This grass, known as the Weeping love-grass, was from Florida. It is reported there to be very drought-resistant and especially suitable for sandy soils. It is also useful for soil conservation purposes. There are possibilities that it may prove useful both in Jaffna and Mannar."

Mr. Vernon Rajapakse inquired whether it is possible to make hay out of this grass.

Dr. Paul replied that in the tropics it is very difficult to make good hay as the strong sun tended to reduce the nutritive value of the grass.

Mr. Spencer Schrader observed that hay making was possible under high shade and believed that coconut estates would be suitable areas for producing hay.

Mr. S. Sivapalan inquired whether suitable steps were being taken for the distribution of cuttings of good grass as in the Dry Zone where pasture was very difficult to establish.

Dr. Paul—"A large number of cuttings have been supplied to those who are interested in growing these grasses. The General Manager of Animal Husbandry Farms has supplied those who purchase cattle from the Polonnaruwa Farm and also to visitors who ask for material. We have tried in every way to popularize this grass. I have written an article on this grass in the "Cattle Breeders' Quarterly" and the response for cuttings has been very good. If any member of the Board desires to have cuttings of Palisade signal-grass he can ask the Department for his requirements."

The Chairman at this stage inquired from the Board whether the Committee should be asked to name the areas that are suitable for different varieties of grass rather than merely drawing up a list of popular names.

Mr. F. C. Cooke, Director, Coconut Research Institute, felt that the Committee should not limit its activities to only naming the grasses.

Chairman—"I think it is the general view of this Board that this Committee should continue to function and investigate grasses from all its aspects and not only from a very restricted aspect. Since the functions of this Sub-Committee would include the general question of pasture grasses in the Island, I think one or two other people who are really interested in the subject should be included in the Sub-Committee."

The names of Mr. R. H. de Mel and Mr. Gladwin Kotalawela were suggested as additional members of the Sub-Committee on grasses and this was agreed to by the Board.

Mr. S. Sivapalan—"I understand from the Chairman of the Sub-Committee that Gate Mudaliyar Wickremaratne has resigned from the Sub-Committee because its scope was not sufficient."

Chairman—"As Mudaliyar Wickremaratne is not too well we might omit his name."

Mr. Sivapalan—"I suggest that the Committee be given power to co-opt any other person who may be useful to give us information on any particular matter."

The Chairman replied that it was not necessary to co-opt anybody else but any person could be invited to a particular meeting and this proposal was accepted by the Board.

Mr. R. H. Spencer Schrader—"Dr. Paul has told us that Sinhalese and Tamil names have been suggested for the various grasses. My only suggestion is that in this English-speaking world, their English names too be included, and that either at Government Stations or if possible at the Schools there should be demonstration plots of the various grasses with all the three names, Sinhalese, Tamil and English so that the popular names of these grasses would be known as widely as possible. When we talk for instance of *Brachiaria brizantha*, people will wonder what we are talking about. I got a very small quantity of it and I can assure you that it is one of the imported grasses that I have found to do extremely well under warm conditions and it is a winner. It appears to be rather like rabbits in Australia because I understand that it does better in Ceylon than in its home country.

The other point I want to mention is in regard to trying out mixtures. At my own place I have got a mixture. I have taken

advantage of the present rains. I have got *Brachiaria brizantha, B. decumbens* and *Panicum trichocladum.* All three are in one plot of two acres with *Centrosema* as the legume and also a certain amount of coarse weed and Guinea grass. They are all growing well. I want to see which grass will dominate and kill the others. I think there are several mixtures which the Department can try out similarly. I understand from Dr. Paul that *Panicum trichocladum* is not doing so well at Peradeniya as at my farm. This is a case of the effect of different soils on various grasses and it is just unfortunate. Various experiments should be tried out in various places and the greatest publicity should be given to the results."

Chairman—"An officer has been sent to Australia to study the question of pastures. He has been there for two years and I hope that this young man would bring with him a great deal of knowledge and information so that his interest in the subject, I am sure, will be of value to the Department. To add to this we are happy to note that we have found a winner in *Brachiaria brizantha.* With the assistance and co-operation of the members of the Department who are interested in the subject, I am sure we will make much headway."

Mr. S. L. Bandara Dharmakirti inquired whether Napier and Guinea grass were good pastures.

Dr. Paul replied that Napier and Guinea were used as fodders and not as pasture grasses. He said that they were discussing pasture grasses and added that the difference between a fodder and a pasture grass was that a fodder had to be cut and fed to stock whereas pastures were directly grazed and were superior from a nutritive point of view. He added that stock could only consume about 50 lb. of fodder (i.e., grass like Napier and Guinea) whereas in the case of pasture, it was about 100 lb. or more. The protein content of a pasture was much greater than that of a fodder grass.

Mudaliyar Abdul Cassim Marikar suggested the addition of a column to the list of names of grasses so that comments such as whether a grass is drought-resistant or not and whether it is recommended for the Dry Zone, &c., could also be included.

This suggestion was agreed to by the Board.

IV—Proposals on Food Production submitted by Gate Mudaliyar N. Wickremaratne

Chairman—"Copies of the proposals on Food Production submitted by Gate Mudaliyar Wickremaratne have been circulated to members. We have also received a memorandum submitted by Mr. A. Godamunne which relates to the same subject. In the absence of Gate Mudaliyar Wickremaratne, I am wondering how we should discuss this matter. Would it be in order if I should take each proposal in the order they appear and ask for comments from the House? We have got officers representing the various Departments and they would then be able to indicate what Government has done or what Government proposes to do in regard to those particular points."

The Chairman then read out the first proposal of Gate Mudaliyar Wickremaratne—

"That more feasible and satisfactory arrangements will have to be made in the prompt purchase of cultivated paddy just after each harvest without allowing room for the third party to buy paddy at cheaper rates and make undue profits. The delay in the purchase causes discouragement and losses to the cultivator."

Chairman—"We have here a representative from the Marketing Department. This has been a subject which was previously undertaken by the Director of Food Supplies, but it has now been entrusted to the Marketing Department. Would you, therefore, like to make a statement on the present position?"

Mr. L. B. Rajakaruna, Deputy Commissioner of Marketing—"Mr. Chairman and Gentlemen—Purchases under the Guaranteed Price Scheme, as you know, are done by the Department of Marketing from November 1st last year. Prior to that this scheme was operated by the Director of Food Supplies for about two years. The position at present is that Government has appointed certain Co-operative Agricultural Production and Sales Societies as sole purchasing agents of Government. The

Marketing Department purchases the paddy from the cultivator through these Co-operative Agricultural Production and Sales Societies. The paddy purchased by Government is now disposed of by two methods. The paddy is milled in the three Government mills and five hullers, and the rice produced is issued to the Food Commissioner to be distributed under the rationing scheme. A certain part of the paddy is also issued under the rationing scheme through the Food Commissioner. We have had various difficulties in the operation of this scheme. Primarily the problem of storage facilities has been a difficult one. I can just outline to the Board the storage capacity which we have got at present. I wonder whether the members would be interested in the detail. In Colombo we have got a storage capacity of 350,000 bushels. In Anuradhapura in the Senanayake Bay, we have a capacity of nearly 45,000 bushels. Additional storage capacity is now being provided at Anuradhapura to the extent of 75,000 bushels. At Hingurakgoda the capacity is about 50,000 bushels. At Polonnaruwa we have got from the Railway two loading points the capacity of which is about 20,000 bushels. At Kekirawa the capacity is 20,000 bushels. In Medawachchiya the capacity is 20,000 bushels and at Batticaloa we have got a storage capacity of 150,000 bushels. At Puttalam it is 20,000 bushels and Vavuniya the capacity is 25,000 bushels. In addition provision has been made in the next financial year to construct additional storage facilities, namely, at Polonnaruwa to the extent of 100,000 bushels and Batticaloa another 100,000 bushels. Certain other proposals for additional storage have not had the approval of Government as yet. As I mentioned earlier, we have three Government mills with storage capacity attached to each of these mills. At Ambalantota we have got a mill which can mill about 700,000 bushels of paddy a year. In respect of the mills we need not have a large storage capacity attached to them because paddy as it comes can be milled and disposed of. But during the last two or three months with the harvesting of the bumper *Maha* crop, a number of problems have arisen in producing areas excepting in the Southern Province. In the Southern Province the problem was that paddy was not coming to the Government mill but was being sold through private organizations at prices which were comparable or even higher than that offered by Government under the Guaranteed Price Scheme. In Batticaloa District very large quantities of paddy have come in and our storage capacity there has been found to be totally inadequate. With the new proposals made next financial year, I trust the storage difficulty will ease in future.

So far as the producer is concerned, he has to offer the paddy to these Co-operative Agricultural Production and Sales Societies which are exclusively our purchasing agents. It may have happened that these Societies may not have had sufficient storing facilities of their own prior to transferring the paddy to Government warehouses or mills or they may have difficulties in finding sufficient loans to purchase paddy to tide over the period at which paddy purchased previously has to be transferred to Government mills and money realized on earlier purchases. They have other difficulties in that paddy purchased by them has to be delivered to Government warehouses or mills on particular days allocated to them. When large quantities of paddy are coming in, we find it rather difficult to cope with the quick taking over of paddy at our stores, and in such cases a programme has been arranged in advance whereby certain days of the week are allotted to each Society.

So far as the memorandum submitted by Gate Mudaliyar Wickremaratne is concerned, I think I have outlined the function which the Marketing Department has at present in the disposal of paddy purchased from the producer through the agency of these Co-operative Agricultural Production and Sales Societies."

Gate Mudaliyar M. S. Kariapper—"Mr. Chairman and Gentlemen, on behalf of the C. A. P. & S. Societies I might say that this Guaranteed Price Scheme has been very good on paper and the Marketing Department programme was based on this. Our difficulty in the Batticaloa District has not been with the farmer or with food production but our difficulty has been with Governmental procedure. About four or five weeks ago a bumper crop was raised in the Batticaloa District but the Societies were not able

to buy the produce. Their loans were not released at the proper time and the proper season with the result that middle-men cornered all that paddy at prices very much lower than the guaranteed price. That is at the level of the Society, but again the Batticaloa Paddy Mill is raising certain difficulties in the way of these Societies by fixing certain quotas on different Societies and saying that a particular Society should bring only one lorry load of paddy and nothing more. Such quotas have been fixed by the Marketing Department so that I really feel that something has to be done to remedy these matters. In actual practice this procedure has been laid down. Now, for instance, the Society to which I belong could not deal with more than 150,000 bushels. That means we did not have adequate storage, and here we did not have timely release of loans for the purchase of paddy. In between I really think that the necessary adjustments must be made with Government machinery and not with the C. A. P. & S. Societies or with our farmers. Just before the Sinhalese New Year these Societies bought large quantities of paddy from the farmer. The farmer had to be paid and the money could not be released and the President of this Society had to go to the Kachcheri and see the Assistant Government Agent and there was a lot of difficulty in getting his money paid in time. These little points in Government procedure go a long way in helping the middle-man to corner the paddy at prices very much lower than the guaranteed price. They often succeed in snatching the cultivators' produce at Rs. 7 or even less. Unless such bottlenecks in Government procedure were eliminated, storage facilities particularly in places like Batticaloa, increased, and produce purchased immediately, the cultivator would be discouraged. In this case the producer has to give his paddy and wait for days and weeks for payment. The representative of the Marketing Department said that there were storage facilities in Batticaloa to the extent of 150,000 bushels of paddy. That is only a drop in the ocean. I think Batticaloa should be considered the granary of Ceylon. We are prepared to produce all the food that the country is urgently in need of. Why don't you take it when it is given to you ? "

Major E. C. de Fonseka—" Mr. Chairman and Gentlemen—I understand that the price of paddy at Hingurakgoda and Nikaveratiya is about Rs. 7.50 a bushel. I do not see any point in Government guaranteeing the price and getting the producer to sell it at such low rates. We have heard of the figures given by the Representative of the Marketing Department about storage capacity at various stores. I do not think that it is going to answer the problem at all. Here the Government is guaranteeing the price and not sticking to that price. I think this House should do something definitely to get in writing that Government would honour the price fixed by them.

In regard to the point that paddy has got to be brought by producers on certain days, I think these are flimsy excuses and I feel very strongly that some definite action should be taken with regard to Government honouring this guaranteed price. "

Mr. S. Sivapalan—" This is a matter which has received the attention not only of this Board but of the whole country. When a guaranteed price was fixed it was intended that the cultivator should get the best out of it. The Marketing Department representative's figures form only a fraction of the requirements. The Director of Food Supplies and the Commissioner of Co-operative Development are again people responsible to see that paddy produced by the cultivator is taken on by Government. What has happened now is that the object of the Guaranteed Price Scheme is entirely defeated. I know as President of a Co-operative Union, that there are difficulties in taking over paddy. But measures should be taken by Government to fulfil the promise given to the people. It is therefore very important that some steps should be taken to co-ordinate the activities of all persons responsible for purchasing paddy direct from cultivators and see that paddy is taken over when offered without any delay whatever." Mr. Sivapalan further explained that that situation was not peculiar only to Batticaloa but it happened in all parts of the Island. Owing to the failure of the C. A. P. & S. Societies to buy the paddy offered by the cultivator, they were forced by financial circumstances to sell to middlemen who come during that season from all

parts of the country and buy the produce at Rs. 6 or Rs. 6.50 per bushel. He added that the cultivator spends four to six months of his time cultivating his fields and at the end of it if he could not realize an economic price for his produce owing to the failure of certain Government activities, it was a very serious matter which deserved the consideration of the Board. In conclusion he said that it was essential to bring this matter to the notice of Government with a request that steps should be taken to co-ordinate the activities of Government in this respect with a view to remedying the poor plight of the cultivator.

Mr. Gladwin Kotalawala said that he would like to know from the Marketing Commissioner whether he was aware that although the guaranteed price of paddy was Rs. 12 sometimes it was sold by cultivators in Uva for Rs. 18. Mr. Kotalawala added that what really happened was that when the price offered by the trader was less attractive, paddy was coming in to the Societies and the Marketing Department and when the price outside was higher, the cultivator offered it to the trade. He emphasized—"What has happened in the past let us forget and let us hope that the new Minister would try his best to stop all this red tape. I hope that the Marketing Department will instruct the C. A. P. & S. Societies to give all facilities to the producer. Now a third party comes in and buys it because when Government steps in there are a large number of difficulties. The Marketing Officer himself admitted that there is not sufficient storage. Now the first point is how can the Minister claim that Ceylon should be self-sufficient in paddy when they cannot afford the facilities for storage? See the amount of money that the country spends on importing rice and see what the position of Ceylon will be in five years time. If those responsible for giving facilities to the producer themselves work in a way that would facilitate the producer to produce more, then he will sell his paddy to Government. I would appeal that the Marketing Department bear in mind all the comments made by members of this Board; and if they do not have funds it is their business to take it up with the Minister. I would like also to ask you whether it is a fact that there is a certain amount of paddy already purchased by Government that goes into the black market?"

Mr. J. M. Sabaratnam—"Chairman—It is really unfortunate that Mudaliyar Wickremaratne is not here. It is more unfortunate that this Board was not able to discuss this matter 2 months ago. The first three proposals of Mudaliyar Wickremaratne show that the present machinery for the purchase of paddy from the cultivator are totally inadequate. There are three Departments which are now interested in the purchase of paddy. There is the Marketing Department, the Department of Food Production, and thirdly, I might say, there is the Agricultural Department. It is absolutely essential that there should be some form of co-ordination between the three Departments in every district of the Island.

I represent the Mannar District, and I find that the price of paddy in this district is in the region of Rs. 9. This has been caused by the inability of the C. A. P. & S. Societies to purchase all the paddy brought by the cultivators, because the Director of Food Production is unable to release the necessary funds.

I would submit that in every district a co-ordination committee be set up with the G. A. or A. G. A. as Chairman with one representative from each of the C. A. P. & S. Societies, one representative from the Department of Agriculture and one representative from the Marketing Department in addition to the Divisional Revenue Officer working in that District. Such co-ordinating committees could bring to the notice of the Permanent Secretary the difficulties encountered in the District. It is useless Government guaranteeing a price if it is not prepared to purchase the paddy immediately it is offered. Unless this is done, the Guaranteed Price Scheme will be a failure."

Mr. A. Perumynar—"Chairman—The price of paddy in the open market for this year is much lower than that offered by the Guaranteed Price Scheme. In the past year the price of paddy in the open market was invariably higher than the Guaranteed Price. Secondly, through the efforts of the Agricultural Department and the Food Production Department we have achieved a bumper rice crop this year. It is at times like this,

when the supply is great and the price in the open market is low, that a large percentage of paddy comes under the Guaranteed Price Scheme. The Government is facing a situation which it was not able to face earlier. It is a welcome thing, because there is more rice produced in the country.

C. A. P. & S. Societies may be a good medium for the purchase of paddy in normal times, but at a time like this when in 2 months the entire *Maha* crop has to be disposed of Government will be well advised to use not only the C. A. P. & S. Societies but other organizations as well. For instance, Rural Development Societies, Co-operative Societies, Co-operative Wholesale units, the A. G. A's Food Control Stores, &c. Why can't the paddy cultivated in this land be handled by any accredited agent of Government? Why should it be restricted to one bottleneck? In some cases the C. A. P. & S. Societies may be about 10 to 15 miles away from the cultivator whereas there may be a Co-operative Stores just next door.

The greater difficulty apart from this is the difficulty of storage which we did not have to face in the past. In regard to storage one important point arises. In each place every week hundreds of bushels of paddy and rice are issued under the Food Control Scheme. In this distribution why should not preference be given to the paddy purchased under the Guaranteed Price Scheme? This would provide storage space for other paddy.

Sir, this a problem we have worked for and come about. It is essential that the cultivator should be able to derive the best benefit from the Guaranteed Price Scheme. If his paddy cannot be purchased for want of storage space, then the scheme should be extended to other organizations like the Co-operative Societies. If Co-operative Societies were to be entrusted with the purchase, they could almost at once distribute the paddy on the rations and thus provide the space for more paddy."

Mr. S. L. B. Dharmakirti—" Sir, one of the difficulties we are experiencing is in the working of the C. A. P. & S. Societies. Unfortunately, the office-bearers of some of these Societies are not strictly honest. In the case of certain Societies although there may be funds available for the purchase of paddy, the cultivator is turned away by one of the office-bearers on the plea that no funds are available. The money is then passed on to a third party to carry out a transaction with the cultivator. In this way middle-men make enormous sums of money."

Mr. C. Wijesinghe—" Chairman—In certain areas of the Southern Province even if the C. A. P. & S. Societies were to carry out purchases round the clock for 365 days they would still not be able to dispose of the paddy offered.

I think it is a tragedy that we who import such a vast quantity of rice from abroad cannot find a decent organization where producers can dispose of their crop quickly. You are fully aware of the existence of an organization which disposes of Rs. 16 million worth of tea every Monday. Have we any such organization that will take in the paddy produced in this country for internal consumption? You are also aware that during the war years there existed an Internal Purchase Scheme where the Headmen were required to take in the paddy offered by the cultivators. I would suggest to you the revival of this Scheme, in addition to the various suggestions put forward by other members. This has been tried out in the past and found to be quick and efficient. The scheme would prevent the enormous losses now being sustained by cultivators. May we suggest to Government that the Internal Purchase Scheme be restored and the Headmen be allowed to take over the paddy offered by the cultivator and to issue receipts which could be presented to the Kachcheri for payment?"

Mr. S. B. Yatawara, Deputy Commissioner of Co-operative Development—" Chairman and Gentlemen—In the first place the trader is accustomed, unlike the Co-operative Societies, to buy paddy at the threshing floor. Besides, that arrangement cannot be made because Government expects a certain standard, which would mean that the Society would have to get the paddy cleaned before selling it to the consumer. The trader buys the paddy irrespective of the grit and chaff it contains. He has his own estimate. We have got to see that the paddy is up to a certain standard.

Then the C. A. P. &. S. Societies are empowered to finance members in all their

needs. The money is provided by the Director of Food Production on an estimate supplied by the Society. But the trader goes to the spot and advances substantial sums to the cultivator to obtain all his needs in return for an undertaking by the latter to sell the crop to the former.

Many members who are in debt to the Society do not bring their paddy to the Society for fear that their loans will be recovered immediately. We know of certain areas where paddy is available and the Society is willing to purchase, but the cultivator reluctant to bring the paddy to the Society for fear of his loan being recovered.

Then, again, as Mr. Dharma Kirti has pointed out, there are Societies which, having the money, inform the producer that no funds are available to purchase the paddy offered.

Some C. A. P. & S. Societies have not been given loans by the Director of Food Production because the earlier loans given have been misapplied. Once the money has been misapplied, it would not be possible for Government to give money again for the same purpose.

We have now about 100 godowns and the capacity of the Societies' godowns is very nearly 1 million bushels. In Mudaliyar Wickremaratne's memorandum it is suggested that we stock paddy for some time to be given out as seed. Societies will find it impossible to keep paddy in stock because they are in debt to the Director of Food Production and they have to pay interest. The longer they keep paddy the more interest they would have to pay."

Mr. M. L. D. Caspersz, Food Commissioner —"Chairman and Gentlemen—In previous years Government never had to purchase so much paddy. Under the Internal Purchase Scheme when paddy was forced out for the consumer, the most the Government got was 40,000 tons, i.e., a little over one month's consumption in the Island. In the last three years the Government has never got more than 10,000 tons of rice from the producer. Can Government suddenly anticipate this year to cope with 40,000 tons ? The quantity is nothing very much, but any way it means quadruplicating the buying and storing resources. We might have been able to handle the doubling of the output, but the quadruplicating of output has been beyond our immediate resources.

So far as storage is concerned, I might say that good storage is not really a problem that cannot be solved. As far as storage in my hands is concerned, I have the equivalent of 7 million bushels of storage space. Unfortunately with the varying amounts of paddy that can be produced, I have also to cater to a certain minimum quantity of imported rice, and it is extremely difficult to offer all that storage for internal production. I really think it is a question of money.

There is another point the Central Board might make. Part of the energies of the Guaranteed Price Scheme are devoted to buying rice from millers. I may state, incidentally, that the Government never guaranteed the price of rice but that it only guaranteed the price of paddy. I would suggest that the Central Board recommend to the Minister that the buying of rice from millers should cease. The Government spends nearly half its resources in this connection on assisting private millers who have more resources than the producer. I strongly recommend that the Central Board put it to the Minister that private millers be left to their own resources and Government confine its assistance to the producer."

Mr. W. M. Coomaraswamy—"Sir, judging from what has been said the whole thing seems to be in a mess. The whole trouble starts with the giving of money. It is high time the Government took over the responsibility of seeing that the money is advanced and collected and storage accommodation is provided for."

Gate Mudaliyar M. S. Kariapper—"Chairman—I really feel that the question of providing storage by the Marketing Department is the problem. I think the Deputy Registrar will bear me out that the Societies could be broken up into small Societies. I must also support the Commissioner of Food that the Government never guaranteed the price of rice. I think it is high time the Government ceased assisting private millers."

Mr. M. Manicka Idaikkadar, C.C.S., Director of Food Production—"Chairman and Gentlemen—I only wish to speak on the

matter of loans. It has been mentioned by Gate Mudaliyar Kariappar that the release of loans is a problem. We have investigated the matter and found that at no stage has any loan been delayed in my office for more than 24 hours. I have taken it as a personal responsibility. I have told Sir Oliver and the present Minister that I would ensure that the cheque is posted the same day, or at the latest, on the following day. That really will not help the cultivator; it is only a personal explanation. Anyway it could not be helped; the actual difficulty was that there were not sufficient funds at the Government Banks in the Kachcheries, but steps have been taken to remedy this.

I would now like to move the following resolutions on the basis of Gate Mudaliyar Wickremaratne's suggestions before the House today :—

(1) That Chairmen, District Agricultural Committees, be responsible to Government in each District for purchase under the Guaranteed Price Scheme and for co-ordinating all activities connected with the Guaranteed Price Scheme.

(2) That the purchase of rice from millers should forthwith be stopped.

(3) That the Government should take steps for quicker disposal of Guaranteed Price Scheme produce under rationing or otherwise, to ease the present insufficient storage accommodation."

Mr. Marcus Rockwood—" Sir, in view of the " Grow More Food " Campaign, and the forecast of bumper crops, I think Government should increase the storage capacity by at least 4 times the normal capacity.

I also wish to suggest that at peak periods a month's ration might be issued at one time to make room for more stocks to be taken in."

Mr. L. B. Rajakaruna, Deputy Commissioner of Marketing—" Chairman—I think it is clear by now that this year we expect very large stocks of paddy. The question of adequate storage has cropped up now for the simple reason that very large stocks have come in. It has been pointed out that the paddy produced is in the neighbourhood of 2 million bushels. Now, I am sure no member here would suggest that Government should provide full storage capacity for 2 million bushels for the reason that this space would have to remain idle for the major part of the year. Just now we have storage capacity for 1 million bushels, and next it is intended to have storage capacity for another 200,000 bushels.

Whenever the open market price of paddy is higher we find that paddy goes outside. But this year we have found that the open market price has been less. That is the reason why very large quantities are coming in. The problem this year is that we have not been able to dispose of this paddy as quickly as we expected to. One wonders why this paddy could not be disposed of. I think the Food Commissioner is the authority for making that arrangement. In certain parts of the country—for instance the Southern Province, as Mr. Wijesinghe pointed out—very large stocks have been produced but the Government has not been able to help the producer in purchasing at the guaranteed price. One member has pointed out that the paddy purchased goes to the black market. I do not know from where he got the information, but so far as I am aware this is not correct."

Mr. S. Sivapalam—" I second the resolutions put forward by the Director of Food Production and request the Government to direct all Government Agents to take over paddy from any source considered suitable."

Mr. C. Wijesinghe—" I suggest that the Internal Purchase Scheme be brought in immediately."

Chairman—" Gentlemen, I think the subject is of great importance, and I propose to send to the Minister, through my Permanent Secretary, with as little delay as possible, the full details of the discussion we have had on it. Then the Minister would have the full views of the members and he could decide on what action he should take. The Director of Food Production has proposed 3 resolutions. I shall send them as formal resolutions of the Board."

Mr. S. Sivapalam—"Mr. Chairman—I would suggest that the resolutions moved by the Director, Food Production, be approved by the Board and then forwarded to the Minister. I wish, however, to suggest the following amendment, if you would agree :—

> "That the Chairman of the District Agricultural Committees take immediate steps to purchase all the paddy produced."

Chairman—"Is it your wish that the Marketing Department should be absolved from this responsibility?"

Mr. S. Sivapalam—"The Marketing Department is not entirely responsible."

Mr. Manicka Idaikkadar, Director, Food Production—"As Chairman of the District Agricultural Committee he controls all the activities. I do not think there is any objection to his co-ordinating the activities. I do not think there would be any objection from any Government Department to the Chairman, D. A. C., co-ordinating and being responsible for this work."

Mudaliyar N. M. Abdul Cassim Marikar—"Sir, may I know whether the Chairman of a District Agricultural Committee who is the Government Agent or Assistant Government Agent is in a position to co-ordinate the activities of a Department so far as the purchase of paddy is concerned. I think the Government Agent or Assistant Government Agent is empowered to summon any assistance and to summon any member of the Committee to accomplish a certain piece of job that is really needed for the District. I believe it is a statutory body and the Chairman, D. A. C., will be in a position to do it. May I know from the Director of Food Production whether the Chairman of a D. A. C., who is the G. A. or A. G. A., is empowered to do this ?"

Mr. N. Manicka Idaikkadar, C.C.S., Director of Food Production—"He is generally empowered to do it. Perhaps he may not take the initiative. But a resolution like this may give him the incentive to do it."

Mr. M. L. D. Caspersz, C.C.S., Commissioner of Food Supplies—"It is correct that the Marketing Commissioner has been entrusted with the functions of purchasing paddy. On the other hand Government Agents and Assistant Government Agents are Chairmen of certain District Committees, not particularly Agricultural Committees, and also of certain District Committees that have been recently appointed, and it will be very easy for him to co-opt any Marketing Department representative there may be. Although that Committee is not expected to meet more than once a month, there should be no difficulty for him to contact the Marketing Department representative, discuss any difficulties and report the results of his discussions to the monthly meeting of the very representative committee which is expected to take in every Government Department within the District."

Mr. L. B. Rajakaruna, Deputy Commissioner of Marketing—"The crux of the matter is that purchasing is done by the Marketing Department through the agency of the C. A. P. & S. Societies. What I think is that the resolution means to convey that the purchasing should not be done by the C. A. P. & S. Societies."

Chairman—"This resolution will cover all that.

Shall we then suggest that the resolution should read as follows :—

> (1) The Chairmen of District Agricultural Committees should be responsible to Government in each District for purchase under the Guaranteed Price Scheme and for co-ordinating all activities connected with it and take such steps as may be necessary for the immediate purchase of all paddy that may be offered under the Scheme.
> (2) The purchase of rice from millers should be stopped forthwith."

The resolution was put to the house and unanimously carried.

Gate Mudaliyar M. S. Kariapper—"We are deeply concerned about the proposed withdrawal of the Guaranteed Price Scheme in 1957. I think it is the opinion of most members of the house that this Guaranteed Price Scheme must go on."

Mr. N. Manicka Idaikkadar, Director of Food Production—"It does not necessarily mean that the Guaranteed Price Scheme will be withdrawn in 1957."

V—Seed Paddy and dates of sowing—Gate Mudaliyar N. Wickremaratne

The Chairman read the following proposals submitted by Gate Mudaliyar Wickremaratne :—

"3. In the first instance the cultivators should be compelled to select and keep seed paddy required for their requirements : Government should try and exchange such seed paddy with pure line or selected seed paddy gradually. This will prevent the scarcity of seed paddy at the time of sowing or unnecessary delay in the timely sowing of paddy in the season."

"4. The dates of sowing for *Yala* and similarly dates of sowing for *Maha* should be collected in time together with extent sown in order to publish statistics. At present there is some confusion on this as in some areas fields are sown in a different date or month some time in one area and a different date in another area, but all that comes within one season. At the time of ripening, agricultural officers should go round and take notes for a possible forecast of yield so that those who are expecting to buy paddy may get ready to do so. When harvesting is over proper statistics can be obtained."

Chairman—"I will ask Mr. de Mel, the Deputy Director, to briefly indicate what the Department of Agriculture is doing in regard to this matter."

Mr. C. N. E. J. de Mel, Deputy Director of Agriculture, repeating the first sentence of item 3, viz.: "In the first instance the cultivators should be compelled to select and keep paddy required for their requirements : Government should try and exchange such seed paddy with pure line or selected seed paddy gradually," said that perhaps it was not a question of compelling the cultivators, but that of the Revenue Officers advising the cultivators. Mr. de Mel added that what really happened was that the price of paddy fluctuated, the price sometimes rising up to Rs. 18. During such periods the cultivators sold their paddy promptly and afterwards came to the Government Agent, or the Assistant Government Agent, with requests for the supply of seed paddy. They (the Revenue Officers) in turn asked the Department to supply them with thousands of bushels of seed paddy. Mr. de Mel emphasized that it was not possible to compel the cultivator, as suggested in the proposals, if they do not keep their own seed paddy.

In regard to the second suggestion of proposal 4, namely, "Government should try and exchange such seed paddy with pure line or selected seed paddy gradually", Mr. de Mel stated that that was exactly what the Department was doing. He added that members would appreciate the fact that the exchange of paddy meant the Agricultural Officers and their staff handling very large quantities of paddy, which involved the question of storage and transport. The Department has devised a scheme in order to eliminate both the question of storage and transport. He then described the scheme briefly, working it backwards thus.

"Supposing a *yaya* is 200 acres, we have to supply a quantity of pure line seed paddy equivalent to double the acreage ; so that for a 200-acre *yaya* the cultivator will require 400 bushels of seed paddy. If we assume, for argument's sake, that 20 bushels is the quantity that will become available as seed from an acre, we will require 20 acres to produce the 400 bushels. These 20 acres will require in turn 40 bushels seed paddy for sowing. We select cultivators who have between them 20 acres in that *yaya* and give them 40 bushels of seed. This requirement of 40 bushels seed paddy can be produced on an extent of two acres. So we appoint a Private Seed Farmer who has two acres, and so start the scheme by issuing him 2 bushels of seed paddy from our Departmental Farms.

For the requirements of this scheme we have appointed some people called Private Seed Farmers, who are preferably Vel Vidanes. The Divisional Agricultural Officer, North-Western Division, has very successfully worked this scheme with the help of Vel Vidanes who have been appointed private seed farmers. This man, known as

the Private Seed Farmer, gets pure line seed paddy from the Departmental Farm. As already explained, 4 bushels of seed paddy issued to a Private Seed Farmer for sowing on 2 acres in the first stage of this scheme will result in 400 bushels of seed paddy sufficient to cover 200 acres in the third stage of the scheme. Therefore with the pure line seed raised on the limited extents of paddy fields possessed by the Department of Agriculture, we can expect to cover the greater part of the Island with pure line seed in three years. Therefore, Mr. de Mel hoped, that all those present would be satisfied that the request contained in clause 4 of the proposals is already being attended to.

Referring to the statement in Mudaliyar Wickremaratne's proposals that "This will prevent the scarcity of seed paddy at the time of sowing or unnecessary delay in the timely sowing of paddy in the season", he agreed that if the cultivator can be compelled to keep his own seed paddy it will certainly ensure that there will be no lack of seed paddy. The farmer can come to the Department and exchange his paddy for pure line seed paddy. Therefore, seed paddy will be available, when sowing starts. Incidentally, he mentioned, the Department had at present 40 pure lines available for issue.

Commenting on the proposal of Gate Mudaliyar Wickremaratne, viz., "The dates of sowing for *Yala* and similarly dates of sowing for *Maha* should be collected in time together with extents sown in order to publish statistics. At present there is some confusion on this as in some areas fields are sown on a different date or month in one area, and on a different date in another area, but all that comes within one season", Mr. de Mel said that Revenue Officers normally summon cultivation meetings at which cultivators were advised on the dates of sowing, so that they were compelled to carry out their cultivation during that time.

Mr. de Mel stated that if people could get together and fix the time of sowing they could reduce paddy pests. He added that unfortunately in the wet zone, owing to rubber and coconut plantations, paddy was a matter of secondary importance and therefore it did not receive that amount of attention which obtained under the irrigation scheme.

Commenting on the clause in Gate Mudaliyar Wickremaratne's proposals, viz., "At the time of ripening, agricultural officers should go round and take notes for a possible forecast of yield so that those who are expecting to buy paddy may get ready to do so. When harvesting is over proper statistics can be obtained", Mr. de Mel stated that in dealing with the last sentence first, there was already a Department of statistics with a very widespread machinery and its bulletins were published regularly. Referring to the first part of that clause he stated that to enable people to buy paddy, there were two agencies—the C. A. P. & S. Societies and the trader. The C. A. P. & S. Societies being in the heart of the area knew when to buy the paddy. But in the case of the trader he did not think any help was necessary from the Department since they were aware of threshing times and were in the habit of purchasing direct at the threshing floor.

Commenting on the suggestion that Agricultural Officers should go and assess the yields beforehand and circulate the information, Mr. de Mel hoped that members would appreciate the difficulty for an Agricultural Officer or a Food Production Officer to do that work along with their other duties.

Mr. J. M. Sabaratnam—"Mr. Chairman—The scheme of the department is very good. But to implement the scheme there are various bottlenecks. The efficiency of the scheme depends on the efficiency of the various officers. You have various seed paddy farmers who are guaranteed a rupee more than the normal price for each bushel of paddy purchased and that seed paddy is supposed to be distributed to other farmers. The difficulty comes in at the time of distribution. They expect the seed paddy farmer to hand over the paddy and subsequently re-distribute it to various other cultivators in the area. Can the Department take the responsibility of taking over this paddy and of distributing it to other cultivators within that small unit? If that is done the Department would have ensured the success of the scheme."

Chairman—" I would like Mr. Jayasundera to speak of the problem."

Mr. E. S. Jayasundera, Divisional Agricultural Officer, North-Western Division—" The cultivator in the *yaya* buys, or exchanges seed paddy with the Private Seed Farmer and therefore the question of C. A. P. & S. Societies having to store the paddy does not arise. I do not know how it is done in other districts. I can claim that it has helped me a great deal because in an acreage of 140,000 acres we got nearly 48,000 acres of pure line."

Mr. Albert Godamune—" I own some paddy land in the North-Western Division but have not been able to get any seed paddy. I have not been called to the meetings of Divisional Revenue Officers where cultivators get together and fix dates for cultivation."

Mr. Godamune added that although he owned land in the Central and Uva Provinces he had not been so far called for any of the meetings of Divisional Revenue Officers in those provinces too.

Mr. E. S. Jayasundera, Divisional Agricultural Officer, North-Western Division—" Besides other cultivators there is Mr. Clement Dias with whose assistance and co-operation we are going to extend the scheme of Private Seed Farmers. There is again in every hatpattu besides the Private Seed Farmers, Vel Vidanes and other gentlemen who come within the scheme—for instance, Dr. Tennekoon, who has 100 acres under Batalagoda Tank. He is a Private Seed Farmer who does not depend on us. The latest addition to this list of private gentlemen owning land is Mr. Jayakoddy who, as you know, has about 60 acres and is doing good work. This is being cultivated under lift irrigation.

There are so many private individuals who are getting paddy from us and doing extension work. If only Mr. Godamune's cultivators were to ask the Agricultural Instructor who is close by he will get what he wants."

Mr. Clement Dias said that with only a few officers at the disposal of the department it was not possible to do all the work arising from the various schemes. He mentioned that he had sent the Department a memorandum on the subject and that nothing had so far been done about it. Commenting on the success he had met with the seed paddy obtained from the Department, he said that from 15 acres of paddy he had obtained a yield of 200 bushels in 1930 through the village cultivators. Two years later he had obtained 400 bushels from the same plot by cultivating the paddy field on estate account. In the current year the yield was nearly 600 bushels. He felt that before long he might be able to produce 1,000 bushels out of the 15 acres. He stated : " I feel sorry for these departmental officers who have to do an area of several lakhs of acres. If the Government wants to establish a good seed farm and produce paddy, you must have proper planning. What is happening is that officers of the Department are doing work, but there is no one to plan. They are educated men and not business men. They must get business men to run the show. That is why I gave this memorandum. In 5 years time we can double our crops."

T. B. Poholiadde Dissawe, M.P.—" We have heard a lot about seed paddy being distributed. May I know what extent of seed paddy there is in the North-Central Province and the Central Province ?"

Mr. G. V. Wickremesekera, Divisional Agricultural Officer, Central Division—" In the Central Province the most variable conditions in the Island exist. Even in a single tract two or three varieties of paddy are required. The attention of officers producing pure line seed is concentrated at present on the larger food production areas. For several tracts in the Central Province, except in some parts of the Kandy and Matale Districts, there are no recommended pure lines. The scheme established in this Division and accepted by the Department is to establish a seed farm in each tract for producing sufficient seed which when multiplied in the tract is sufficient to meet the seed requirements of the entire tract. Where these are recommended pure lines, they are multiplied on the seed farms. Where no pure lines have yet been recommended, the most popular local variety is mass selected, multiplied and issued, just as in the case of pure lines. These seed farms are not merely for the production of seed but also for demonstration purposes. The best cultural method for a particular tract is

demonstrated. These seed farms are combined demonstration centres and are established in every paddy tract in the Central Division. Sometimes owing to the vagaries of the weather the normal variety is not grown and shorter termed varieties are grown in the tract. The following corresponding season the introduction of pure line seed has to be started afresh. That is why in certain areas we have not been able to cover the entire area with pure lines."

T. B. Poholiadde Dissawe, M.P.—"Are these seed farms known only to the Department and its officers? I own land in the Central Province and North-Central Province. I have heard of seed farms only on paper and at the District Agricultural Committee meetings, but there is nothing beyond that. Since late the Agricultural Department has been enlarged to a very great extent. Ten years ago there were only Vel Vidanes. Now every D. R. O's Division has a Food Production Officer. He is given the assistance of a number of Overseers. These Overseers are personally known to me and I am in close touch with some of their work. I wonder whether you have a check on the work done by them. I believe that the statistics contained in your various magazines are based on the figures given by these people. They are all false and I can prove that. I read in the "Daily News" that the Government has found these people to give incorrect information and that you are taking steps to devise some measures to check the correctness of these figures. I hope this will be done. But if you go to lay your trust and the trust of the country on these people, you are only publishing fictitious figures for the information of the public."

Chairman—"On the point raised by Poholiadde Dissawe I would like to say that for the last three years we have had an officer sent by an International Organization—the F. A. O—to Ceylon to help us to arrive at correct estimates of yields of paddy. This officer devotes a great deal of time to this matter. He has brought in all organizations concerned in the country, viz., Revenue Officers, Statistical Officers, Agricultural Officers, Rural Development Officers and others in order to arrive at correct estimates. I think you will agree that the figures collected in the past were not reliable. This F.A.O. Officer has at least furnished us with some figures of estimated yields and I think we can, with a certain amount of satisfaction, say that our yields are not as low as those previously reported for Ceylon. Our yields have now been found to be about 27 to 30 bushels per acre per season. These figures have been estimated over three seasons and this is the fourth season in which the estimation is being carried out. Therefore, I would like to say that these figures are not fictitious as Poholiadde Dissawe would let us believe. There may be some officers who do not give us the true story, but I do not think the majority of them are so bad. I should say that practically all of them have a strong sense of responsibility. In this matter of obtaining estimated yields, it is not one group of officers, but various groups of Government Officers that came into the picture, and I think we should have to take these figures with a great measure of trust."

Mr. J. O. Sabaratnam—"I suggest that next time Mr. Koshal takes his survey he includes pure lines as well."

Chairman—"I think that is being done."

T. B. Poholiadde Dissawe, M.P.—"We have brought under cultivation thousands and thousands of acres in the Dry Zone under new Schemes. The question is what percentage increase in yields have you shown from the unfertile paddy fields that existed before these new lands were taken up for cultivation. We ought to be able to show the rate of increase in yields from old lands and not merely increase in yields from a combination of both. I know in the North-Central Province we have got thousands and thousands of new land brought under cultivation under colonization schemes, and under village expansion schemes; and the Department gets their big yield-figures from these lands. I am trying to find out whether the Government is able to show a substantial increase in the yields of the neglected paddy fields. If that is done, we have achieved success. On large acreages of ancient paddy fields the yield remained the same. My question is whether there are sufficient steps taken by the Agricultural

Department or Food Production Department to improve conditions of these lands —800,000 acres in extent in the whole Island ? "

Mr. Albert Godamune—" How many seed stations have you got in the pata Hewaheta ? "

Mr. G. V. Wickremesekera, Divisional Agricultural Officer, Central Division, stated in reply that there were a large number of seed farms, one at least in every paddy tract, but there were no departmental seed stations.

Senator Justin Kotalawala—" Where are the pure line stations in the Western Province ? "

Mr. C. N. E. J. de Mel, Deputy Director of Agriculture—" There are departmental stations at Panagoda, Bombuwela, and at Walpita."

Some members expressed the wish that the location of seed farms and their acreages should be given publicity.

Mr. C. N. E. J. de Mel, Deputy Director of Agriculture—" The number of seed farms, their acreages and the amount of seed paddy that could be expected are circulated by the Divisional Agricultural Officers to the Revenue Officers. "

Mr. N. Manicka Idaikkadar, Director of Food Production—" Mr. Chairman, if I remember right, Dr. Koshal said once that the yields from the Purana fields, particularly in the Anuradhapura District, have been much higher than in the new fields. I would like to tell Poholiadde Dissawe that it is so, and not the converse. Secondly, I am sorry that a man of his standing should ask us what we are doing for the Purana field owners in the Anuradhapura District. I wonder whether he is under the delusion that Government should asweddumize fields, provide houses and irrigation facilities to Purana field owners as is done in the case of Colonization Schemes. I can give a definite 'no' in this matter. The present practice of the Government is to provide the cultivators with the necessary incentives, advice and loans, and also facilities for marketing, purchasing, &c., but the cultivators themselves must co-operate. Credit facilities are available through the C. A. P. & S. Societies, but, as the Deputy Registrar rightly pointed out, unless people co-operate we cannot function. Efficiency to a great extent depends on the co-operation of people and of the Government officials concerned.

The question of providing minor irrigation facilities, raised by Mr. Godamune, has been receiving our attention ever since Mr. Godamune mentioned it at the first meeting of the Central Board of Agriculture.

Obtaining loans and grants from various other organizations, we have provided for a reasonable sum for local minor irrigation schemes.

If a particular officer is found wanting, the answer is both with the Department concerned as well as with the people. The superior officers concerned should readily deal with him, but at the same time I should point out that if an officer is found wanting there is no use in Government employing him. If an officer is not doing his work, I feel that he should be sent out. I do not know whether I am expressing the Government view, but that is my personal view on the matter.

We shall be only too glad to help the cultivator with facilities by way of technical advice, loans, &c. But the people themselves must produce."

Mr. Albert Godamune—" As regards North-Central Province, even today, as in the past, villages are getting extinct. In 1880 when Governor Gordon began opening major tanks the question was definitely settled that land under major irrigation schemes should not be asweddumized. In 1932 that policy was changed. Today all the water collected in the major irrigation schemes are utilized for Colonization Schemes, and if you ask Mr. Hatch, who is doing some Adult Education work at Hingurakgoda, he will show you a list of 56 villages round Hingurakgoda where the people are dying out ; and the rate of dying out is more today than it was when the North-Central Province major irrigation schemes were started."

Mr. C. R. Karunaratne, Agricultural Officer, Dry Farming—" Poholiadde Dissawe will recollect that during my period as Divisional Agricultural Officer, I concentrated my attention on villages and village works. He will realize that we started with a small number

of 45 villages and by the time I left the Division, last year, there were 253 villages. The scheme of development I had undertaken during that period was not turning out pure line for half acre or one acre blocks but for larger *yayas*. He will remember that an entire *yaya* of paddy fields or a whole village tract was cultivated during the *maha* season. I embarked on that scheme because I had a major irrigation scheme nearby. To substantiate my statement I might state that the Hon. Bulankulame Dissawe himself visited these fields. I had proved, by taking on-the-spot random cuttings, that we were able to step up production from 20 to 80 bushels. It is regrettable that Poholiadde Dissawe was unable to be present on most of these occasions due to ill-health.

I entirely agree with Mr. Godamune that the feeder-tank system has been very useful in irrigation and this is exactly what our villagers have been making use of. According to the feeder tank system, the water flowing from major tanks are conserved in village tanks, and the water flowing from these village tanks are used for paddy fields lying lower down. But now with the new system of irrigation, the village tanks are denied this flow of water, and this has made it necessary for the people so affected to be absorbed into Colonization Schemes.

Referring to the remarks made by Poholiadde Dissawe that the figures furnished by the Department are fictitious, I think I have clearly illustrated an instance of how paddy yields were stepped up from 20 to 80 bushels and how the figures were assessed by sample cutting surveys. It is therefore unfair by the Department that Poholiadde Dissawe should make such a statement.

I however agree that, with the meagre staff we have, it would not have been possible for us to concentrate on every village and every field, but at the time I left the Province I had stepped up the number of villages from 45 to 253."

T. B. Poholiadde Dissawe, M.P.—" Now I realize that the fault does not lie with the Agricultural Department but instead with the Irrigation Department. My actual grouse is that the bona fide villager of the place (the purana field owner in the North-Central Province) is being put into difficulties. With the new irrigation facilities the owners of new land are doing well, whereas the owners of old are still at their low figures of yields. If the Agricultural Department or the Food Production Department or the Irrigation Department made the mistake, it is our Government that is to blame, and it is our duty to point to Government what damage it has done."

Chairman—" The time is now 5.15 p.m. and I suggest that we discuss the next part of Mudaliyar Wickremaratne's proposals in Colombo at our next meeting. Since it is our intention to change the venue for the next meeting, i.e., in Colombo, we might have the pleasure of having the Minister with us."

VI—" Govikam Sangarawa "

Item 5 of the agenda read as follows :—

" Translation of the Departmental Journal, *Tropical Agriculturist*, &c., into Sinhalese—Discussion to be initiated by Agricultural Officer, Propaganda, Mr. S. B. Yatawara."

Chairman—" Senator Justin Kotalawala has proposed that the *Govikam Sangarawa* should contain articles translated from the *Tropical Agriculturist*. We had a discussion this morning and it was indicated to him that our policy is not to reproduce such articles in full, because they are of a scientific nature and may not be of much interest to the readers of the *Govikam Sangarawa*. It is our intention to publish a popular rendering of some of the material together with other popular articles which deal with matters of interest. I think he agrees with me that this will meet the purpose indicated by him. I think the Propaganda Division, which is responsible for this journal, will bear that in mind."

Mr. Albert Godamune—" The Department publishes a News-Letter for the information of the Department. Would it be possible to send it on to the members of the Board ? "

Chairman—" The News-Letter sets out briefly some of our recent findings in research. This is a recent publication started in November last year. We have exhausted the issues so far published. It is issued in

three languages: Sinhalese, English and Tamil. I entirely agree that the members of the Board of Agriculture should also receive copies."

Mr. Gratien Silva, Assistant Agricultural Officer, Propaganda, stated that translations from the *Tropical Agriculturist* were being included in the *Govikam Sangarawa* at present. He added that since most of the articles in the *Tropical Agriculturist* were of a technical nature only articles of general interest were published in the *Govikam Sangarawa.*

VII—Any Other Business

The Chairman stated that Mr. R. T. Chelliah had made a proposal that members of the Central Board of Agriculture who are not members of District Agricultural Committees in their respective areas should be co-opted to those Committees so that they might express their views on various agricultural matters.

The Chairman had no objection to bringing the resolution up. He however requested the Director, Food Production, to kindly express his opinion on the matter.

The Director of Food Production suggested that a classified list of members of the Central Board of Agriculture who are not members of District Agricultural Committees be drawn up and forwarded to the Permanent Secretary.

The Chairman inquired at this stage whether members of the Central Board of Agriculture who were not already members of District Agricultural Committees could be invited for any special discussions of District Agricultural Committee meetings.

Mr. R. T. Chelliah stated that his suggestion was that members of the Central Board of Agriculture should be invited for all District Agricultural Committee meetings and not just for any particular meeting.

Mr. N. Manicka Idaikkadar, Director of Food Production, stated that under the existing Ordinance the Chairmen of District Agricultural Committees have the right to invite any person they desired for the meetings.

Mudaliyar N. M. Abdul Cassim Marikar—"Those competent to advise the Chairmen of the District Agricultural Committees should, in my opinion, be co-opted or appointed to the District Agricultural Committee of his District." Mr. Godamune expressed the view that as members of the Central Board of Agriculture they had a right to know what was discussed at the District Agricultural Committee.

Mr. F. C. Cooke, Director, Coconut Research Institute, endorsed the view that members of the Central Board of Agriculture should be co-opted or appointed to the District Agricultural Committee as this was a very important body.

Chairman—"If you would like to move it as a resolution I will forward it to the Permanent Secretary."

Mr. R. T. Chelliah moved the following resolution:—

"Members of the Central Board of Agriculture who are not already members of District Agricultural Committees should be co-opted to the District Agricultural Committees of their respective areas."

Mr. Abdul Cassim Marikar seconded the resolution, which was accepted unanimously by the Board.

Mr. S. Sivapalam—"It is understood that the Government of Japan has invited a delegation from Ceylon to Japan to study methods of rice cultivation, &c., in that country. I hope the Department of Agriculture is represented in this delegation."

Chairman—"On that point I would like to say a few words. It has been agreed by Government that three Agricultural Instructors should be sent to Japan to study methods of rice cultivation over a period lasting about 6 months. Steps are being taken to give effect to this decision.

About the other point mentioned by Mr. Sivapalam, I have been advised by my Ministry that the Ceylon Government has been invited by the Government of Japan to send a deputation to Japan to study certain problems of interest to Ceylon. All I can say is that one of the members of this Deputation is an officer of this Department. I have not been told who the others are."

Mr. A. M. Clement Dias—" If it is paddy, I think an expert should be selected."

Chairman—" These are matters of Government policy."

At this stage Mr. Gladwin Kotalawala raised a question as to why the Sub-Committee on Food Production had no sittings so far.

The Chairman explained that if there were certain issues which needed detailed examination on particular aspects of the subject then those details were referred to that Sub-Committee for consideration. As it so happened, the matters discussed up to date had been of general interest to every member and a situation had not yet arisen for any particular issue to be referred to that special body. He added that Food Production was a matter of interest to every member and that it should preferably be discussed at a general meeting than at a Sub-Committee meeting.

In reply to a question from the house, Mr. M. L. D. Caspersz, Commissioner of Food Supplies, said that approximately 400,000 tons of rice were imported into the Island in 1950; a slightly lesser quantity than in 1950 was imported in 1951; 1952 imports were the same as for 1951; in 1953 470,000 tons were imported.

At this stage Mr. F. C. Cooke, Director, Coconut Research Institute, proposed that the question of the economies of poultry keeping be discussed at the next meeting of the Central Board.

Gate Mudaliyar M. S. Kariapper proposed that the Department of Agriculture should, with the assistance of other departments, such as the Forest and Land Development Departments, undertake the compilation of an agricultural atlas.

The Chairman replied that action was being taken to prepare such an atlas and Gate Mudaliyar Kariapper replied that he was happy that the proposal had so readily been accepted.

The meeting terminated at 5.30 p.m.

A. J. Joseph,
Secretary,
Central Board of Agriculture.

Peradeniya, May 16, 1954.

ANIMAL DISEASES RETURN

January - March, 1954

Province	Disease	Fresh Cases during Quarter	Total Number to end of First Quarter, 1954				Balance ill at end of quarter
			Diseased	Deaths	Shot	Recoveries	
Western Province (excluding Colombo Municipal area)	Rabies	79	79	—	79	—	—
Northern Province	Anthrax	50	50	50	—	—	—
	Rabies	4	4	—	4	—	—
	Black Quarter	11	11	10	—	—	1
North-Central Province	Foot-and-mouth	795	795	4	—	784	7
	Rabies	2	2	—	2	—	—
North-Western Province ..	Rabies	4	4	—	4	—	—
Central Province	Rabies	15	15	—	15	—	—
	Piroplasmosis	4	4	—	—	4	—
Province of Sabaragamuwa ..	Rabies	4	4	—	4	—	—
Province of Uva ..	Rabies	4	4	—	4	—	—
Eastern Province	Foot-and-mouth	533	533	75	13	422	23
	Mange	85	85	17	—	8	60
Southern Province	Rabies	11	11	—	11	—	—
	Bovine Farcy	12	12	1	—	11	—

Department of Agriculture,
Peradeniya, May 3, 1954.

M. Z. MAHAMOOTH,
Deputy Director (Animal Husbandry) and
Government Veterinary Surgeon.

METEOROLOGICAL REPORT

January - March, 1954

Summary

The rainfall in January was above average in the extreme northern and southern portions of the Island but was irregularly distributed on either side of average in the other areas. The greater deficits (of the order of 5 inches or more) occurred mainly on the north-eastern slopes of the central hills, while the greater excesses (of the order of 5 to 10 inches) occurred in the south. Rainfall was heaviest on the north-eastern slopes of the hills, where a few stations recorded totals over 20 inches. The rainfall was least in the western low-country and on the western slopes of the hills. The weather during the month was mainly of the north-east monsoon type with fairly general rain in the north and east and on the north-eastern slopes of the hills and occasional evening thundery showers in the south-west.

The rainfall in February was above normal in the southern half of the Island and below normal in the northern half. In the southern half, the greater excesses, of the order of 5 to 10 inches, occurred on the north-eastern slopes of the hills and, in places, in the south-western low-country and Batticaloa District. The deficits were generally small (less than 2 inches). The rainfall was heaviest on the north-eastern slopes of the hills, where the monthly totals ranged from 10 to 20 inches. Similar totals also occurred, in places, in the south-western low-country and Batticaloa District. Elsewhere in the southern half, the monthly rainfall was of the order of 5 inches. In the northern half of the Island the rainfall was below 2 inches, about 30 stations in the Northern and North-Central Provinces receiving no rain at all. North-east monsoon weather prevailed generally during the first three weeks and inter-monsoon weather thereafter. Monsoon rain was moderately heavy on the north-eastern slopes of the hills between the 9th and 11th, when several daily falls over 3 inches were recorded. Evening thundershowers were experienced frequently in Hiniduma-Deniyaya area during the last week. Dry weather prevailed over the whole Island during the period 15th to 18th.

Inter-monsoon thunder activity was well in evidence during March. Although, at the beginning, the weather over the Island was practically dry, evening thundershowers which commenced in the extreme south about the 7th spread northwards swiftly and were fairly widespread from the 9th to 27th. Many stations in the south-western parts and to south of the central hills recorded rainfall frequently during this period. Rainfall was locally heavy on some days, with a number of daily falls exceeding 4 inches being recorded. The greater monthly totals, of the order of 20 to 30 inches, occurred in the Western and Sabaragamuwa Provinces, with Weweltalawa Estate recording as much as 42.55 inches. Elsewhere in the south-west the rainfall was of the order of 10 inches or so, while in the north-central parts it ranged from 5 to 10 inches. Least rain was recorded in Jaffna Peninsula, where the monthly receipts were of the order of 2 inches only. On account of this heavy rain, rainfall was considerably above normal in the south-western parts where several stations recorded excesses over 10 inches. In other parts of the Island too, the rainfall was mainly above normal. Deficits occurred chiefly in the south-eastern parts and in Jaffna Peninsula.

D. T. E. DASSANAYAKE,
Director.

Station	January									February			
	Temperature				Humidity		Rainfall			Temperature			
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night from Minimum	Total	Offset	Number of Days	Mean Maximum	Offset	Mean Minimum	Offset
	°	°	°	°	%	%	Ins.	Ins.		°	°	°	°
Anuradhapura ..	84·3	+1·0	70·4	+1·2	80	95	6·55	+0·75	14	89·0	+2·0	69·3	0
Badulla	76·7	+0·5	65·6	+1·9	83	95	9·81	—0·51	22	79·2	+0·2	63·7	+0·6
Batticaloa	81·6	+0·1	73·8	+0·3	85	95	12·08	—0·80	17	83·2	+0·3	73·6	—0·1
Colombo	85·5	—1·0	72·8	+1·0	72	88	7·33	+3·37	11	86·8	—0·4	72·2	+0·1
Diyatalawa	72·9	+1·2	59·9	+2·3	87	97	6·35	—0·29	24	76·7	+1·9	57·6	+0·8
Galle	83·7	—0·1	74·1	+1·2	78	90	8·97	+5·09	13	84·9	—0·3	73·9	+0·2
Hambantota	84·5	—0·5	73·4	+0·8	82	93	7·79	+3·79	16	85·4	—0·6	73·2	+0·2
Jaffna	83·2	+0·2	72·8	+0·7	75	90	6·06	+1·65	13	86·7	+1·1	73·1	+0·8
Kankesanturai ..	82·8	—	74·6	—	77	84	7·03	—	11	85·9	—	74·6	—
Kandy	82·2	—	67·2	—	75	90	4·13	—	18	85·4	—	65·9	—
Kurunegala	86·1	—0·4	71·4	+1·6	72	88	1·48	—3·63	14	89·5	—0·5	69·6	0
M'Illuppallama ..	83·2	—	70·4	—	78	93	3·47	—	13	88·1	—	69·4	—
Mannar	83·3	0	74·9	+0·7	76	86	4·89	+1·05	11	86·6	+0·4	75·0	+1·2
Nuwara Eliya ..	68·6	+0·9	52·0	+5·2	82	91	5·58	—1·38	19	70·4	+0·8	48·0	+2·9
Puttalam	85·8	+0·4	71·8	+1·8	76	93	2·63	—0·80	12	88·6	+0·3	70·9	+0·6
Ratnapura	89·2	—0·1	72·7	+1·6	74	95	4·68	—1·58	15	91·9	+0·3	71·4	+0·1
Ratmalana	86·5	—	73·4	—	72	88	2·79	—1·36	12	87·9	—	73·1	—
Talawakele	73·9	—0·3	57·4	+2·0	80	91	3·62	—0·25	16	76·7	+0·3	55·3	+0·8
Trincomalee ..	80·6	+0·1	75·7	+0·5	84	86	7·76	—0·55	20	82·7	+0·2	76·0	+0·2

Station	February (contd.)					March								
	Humidity		Rainfall			Temperature				Humidity		Rainfall		
	Day	Night (from Minimum)	Total	Offset	Number of Days	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)	Total	Offset	Number of Days
	%	%	Ins.	Ins.		°	°	°	°	%	%	Ins.	Ins.	
Anuradhapura ..	70	95	0·09	—1·63	2	90·2	—1·2	71·2	—0·4	72	95	10·19	+ 6·04	16
Badulla ..	76	94	5·92	+2·75	9	82·3	—0·1	65·6	+1·3	75	95	3·91	+ 1·14	16
Batticaloa ..	81	95	4·94	+0·73	11	85·3	—0·1	74·9	—0·1	81	95	5·33	+ 1·86	14
Colombo ..	72	93	5·54	+2·94	10	86·7	—1·3	73·3	—0·7	75	93	9·73	+ 5·07	16
Diyatalawa ..	74	88	1·92	—0·45	7	78·8	+1·2	59·6	+1·5	74	86	7·49	+ 2·60	20
Galle ..	77	90	4·32	+1·03	14	85·5	—0·9	74·7	—0·4	78	90	7·85	+ 2·54	19
Hambantota ..	79	93	2·45	+0·99	7	87·0	+0·1	74·3	0	77	90	7·59	+ 4·20	7
Jaffna ..	69	90	0·02	—1·44	2	88·4	—0·3	75·9	0	70	88	2·44	+ 0·86	10
Kankesanturai ..	70	86	0	—	0	87·5	—	76·7	—	74	88	3·69	+ 2·22	9
Kandy ..	67	92	4·52	—	7	87·0	—	66·9	—	69	95	10·08	—	18
Kurunegala ..	64	95	2·69	+0·70	5	90·6	—2·1	71·5	—0·6	66	95	14·73	+ 8·45	17
M'Illuppallama ..	67	92	0·21	—	5	89·6	—	71·2	—	70	95	8·09	+ 3·45	15
Mannar ..	68	84	0·13	—1·57	1	88·2	—1·2	76·4	+1·1	70	86	2·81	+ 0·97	9
Nuwara Eliya ..	70	87	2·73	+0·74	11	70·3	—0·6	51·2	+4·9	74	84	4·96	+ 0·87	18
Puttalam ..	70	93	1·39	+0·02	7	89·7	—0·2	72·6	—0·4	73	93	9·49	+ 6·41	17
Ratnapura ..	70	95	14·16	+8·86	16	92·4	+0·3	72·2	—0·3	75	95	16·29	+ 5·91	25
Ratmalana ..	67	86	3·57	+0·21	8	87·8	—	74·0	—	70	88	18·14	+11·66	16
Talawakele ..	70	72	1·27	—0·70	10	76·7	—1·2	57·7	+2·4	70	83	3·46	— 1·16	16
Trincomalee ..	77	84	0·89	—1·76	4	84·8	—0·7	77·1	+0·6	78	86	4·51	+ 2·21	10

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TROPICAL AGRICULTURIST

Volume 110 July-September, 1954 Number 3

Published Quarterly By
DEPARTMENT OF AGRICULTURE
PERADENIYA, CEYLON

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Registered as a newspaper in Ceylon.

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EDITORIAL

Crop Protection

It is common knowledge that world losses of food due to pests and diseases are very high. These losses have been estimated to be as much as 30 per cent. of production by a competent authority—Professor Wain of Wye College, U. K. Estimates by other workers reveal that the loss due to pests and diseases in agriculture the world over is equal to the entire crop of the U. S. A., the magnitude of which can be imagined. In Great Britain alone the loss is estimated at being equivalent to about 1.75 million acres of crop approximating in value about £80 million per annum. In addition there are losses of labour, material and other resources. In the U. S. A. the loss in 1951 through pests and diseases was reported to be approximately $6 billion or about 32 million acres of crop. Apart from losses in cultivation, losses in storage are also considerable, though it is difficult to estimate what these may amount to as a world average. Competent authorities, however, estimate that insects destroy at least 5 per cent. of the world production of cereals in storage, and it will, therefore, not be unreasonable to assess world losses from pests and diseases on all crops at about 10 per cent. of production. When we consider that the world population is increasing at the rate of about 25 million per annum and that we are not producing all the food required to feed even the present population, it will readily be conceded that any measures adopted to reduce these losses would be worthwhile provided they are economic and practicable.

Biologists, entomologists and plant pathologists have during the past 50 or 60 years made considerable advances in our knowledge of the nature of pests and diseases affecting our economic crops and of the measures necessary for their control. The latter may be briefly classified under the following heads : (1) agronomic and mechanical measures, (2) biological control, (3) the breeding of resistant varieties, and (4) the use of chemical fungicides and insecticides. It is hardly necessary to enter into a discussion of the details of these methods of crop protection. But it would suffice to indicate that considerable progress has been made under each of these categories of disease and pest control. The most noteworthy advances in recent times have been recorded in the field of chemical control. It is estimated that the cost of chemicals used for this purpose the world over approximates £300 million per annum and the value of crops saved thereby a minimum of £600 million per annum. By the expenditure of this sum it is reckoned that 40 million additional people are fed through the resultant increased crop yields. In other words 1/60th of the world's population is sustained through chemical crop protection.

History is replete with examples of the far-reaching social consequences of epidemics of pests and diseases on economic crops, but mention need only be made of the potato blight of Ireland which resulted in the Irish famine during the forties of the last century and of the coffee leaf disease of this Island caused by the fungus *Hemilea vastatrix* which brought economic ruin to so many enterprising planters of the time in the later decades of the century. In those days methods for the control of plant diseases were hardly known to science, but most diseases and pests have since responded to the adoption of one or other of the numerous measures which are now in operation for their control. Some of the landmarks in chemical pest and disease control are : the discovery of the value of arsenicals for the control of Colorado beetle, of the fungicidal properties of copper by Prévost in 1809 and its use as Bordeaux mixture by Millardet in 1884, and the use of the chlorinated hydrocarbons, e.g., D. D. T. and B. H. C. (benzene hexachloride) as pesticides during and after the Second World War and of the organo-phosphorus compounds in more recent years. Some of these latter have a systemic action, i.e., they are absorbed by the tissues of the plant and translocated elsewhere so that insects feeding on any part of the plant are killed. The great disadvantage of this group of chemicals is that they are very poisonous and must be used with extreme care. Despite striking advances in the science of plant protection, certain diseases have yet defied men of science, e.g., the sudden death disease of cloves in Zanzibar, the eelworm disease of potatoes, tomato, etc., and the swollen shoot disease of cacao in West Africa. There is, however, every hope that remedies for even these will sooner or later be found.

In this issue of the *Tropical Agriculturist* is published a number of articles by officers of this Department on pests and diseases of certain economic crops and of their control. These articles merit the serious study of all those connected with the production of food in this country. They do indicate that satisfactory methods are now available to the industrious cultivator to prevent, to a large extent, losses of crops through depredations of insects and fungi. It is reckoned that the cost of chemical and application for the control of many pests of paddy will not exceed Rs. 8 per acre, and that in most cases it will be about Rs. 6. This is less than the value of a bushel of paddy and underlines the economic advantages of pest control by the methods indicated. Apart from the question of suitable insecticides for use against crop pests, the types of spraying or dusting equipment which will give the best results have also been studied locally. The article by H. E. Fernando in this issue will, therefore, be of much interest to many of our readers. In a country like Ceylon where our cultivators have yet to be educated in modern methods of pest and disease control by the use of chemicals, it is necessary that a strong extension service be set up to carry the results of scientific investigation in this field of activity to the cultivators. It is gratifying to state that Government has recognized the urgency of this need and has decided on establishing such a service without delay. This has been rendered possible through the generous gift of the

Canadian Government to the Government of Ceylon under the Colombo Plan Technical Aid Scheme of ten Pest Control Units comprising vans, sprayers, dusters and ancillary equipment.

In other fields of agricultural enterprise in Ceylon also, namely, in the tea, rubber and coconut industries, the control of pests and diseases has met with remarkable success. This was largely due to the pioneer work of T. Petch, E. Green, and others on the fundamental problems of crop protection in the tropics against fungi and insects. In recent years mention should be made of the successful control of the blister blight (*Exobasidium vexans*) of tea and of *Oidium* in rubber by fungicides. The coconut caterpillar (*Nephantis serinopa*), which is so devastating in its effects in certain parts of the country, has also been controlled by a method which is not only very economical but effective and practicable. This is the method of biological control of the pest through the agency of an insect parasite (*Trichospilus pupivora*) introduced into the area. Another instance of the successful control of a pest by biological means is that of tea tortrix (*Homona coffearia*) which has been successfully controlled by the parasite *Macrocentrus homonae*. There are a number of other classical instances of the control of pests by this method, e.g., the coconut moth in Fiji, but these need not be enumerated here. Biological control has also been utilized for the control of weeds, an example in point being the prickly pear in Australia which was controlled by the cochineal insect.

The breeding of resistant and immune varieties of crops offers a valuable means of preventing or reducing the depredations of pests and diseases. There are numerous examples of the successful adoption of this method, e.g., the production of potato varieties immune to wart disease, the breeding of rust-resistant varieties of wheat, oats, etc., and, in Ceylon, of a bacterial wilt-resistant brinjal. This method offers the best promise for the control of the blast disease of paddy (*Piricularia oryzae*) which may in certain seasons and under certain circumstances cause considerable damage to the crop.

Agronomic measures are, however, the most feasible for reducing the incidence of pests and diseases. Good plant sanitation and crop husbandry together with the proper timing of crop sowing in order to avoid pests will more than repay the extra trouble taken. A good illustration is the control of the paddy fly in Ceylon. If only sowing were done at the same time and with the same variety of paddy in a single tract, there will be much less damage from the attacks of this pest than does occur in many tracts where different-aged varieties of paddy are cultivated at varying times and under varying conditions.

Before concluding this review of the present position of crop protection in the world and of the methods adopted for achieving our objectives, mention should be made of the great importance of plant quarantine in preventing the dissemination of diseases and pests from one part of the

world to another. In all advanced countries legislation has been enacted to prevent the importation of planting material unless due safeguards have been taken. This aspect of plant protection is of greater importance now than in the past, with the development of air transport, and any measures directed to make it more effective would undoubtedly result in safeguarding crops from pests and diseases in areas where these do not already exist.

In the context of the present world food situation it is incumbent on all persons concerned with the production of food and other economic crops to adopt every possible method for the control of pests and diseases owing to the very appreciable losses to the world stocks of food and other commodities which these cause. In the words of George Ordish, the author of *Untaken Harvest*, 'Tomorrow even less than today can the world support the loss of its Untaken Harvest'.

Paddy Pest Control in Ceylon

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I Paddy Pests and their Control with Chemicals

Introduction

THE paddy crop in Ceylon is susceptible to attack by at least six major insect pests. These pests belong to the insect orders Hemiptera, Lepidoptera and Thysanoptera. Among the Hemiptera or plant-sucking bugs, the paddy bug, *Leptocorisa varicornis* F., the paddy pentatomid bug, *Scatinophara lurida* Burm., leaf hoppers of the genera *Nephotettix, Tettigoniella* and *Erythroneura* and a fulgorid *Niloparvata greeni* Dist., while among the Lepidoptera, the stem borer *Schoenobius bipunctifer* Wlk., and the swarming caterpillar *Spodopetra mauritia* Boisd, are major pests of paddy. The paddy thrips, *Thrips oryzae* W., is the only Thysanopteran which is a major pest of paddy. Certain Diptera like the paddy stem fly, *Atherigona* sp., the paddy gall fly, *Pachydiplosis oryzae* W., and Lepidoptera like the paddy case bearer, *Nymphula depunctatis* Guen., and other leaf-eating caterpillars like those of *Parnara* sp., *Boralia venalba* Mo., *Marasmia bilinealis* Hmpsn., are the less important pests of the paddy crop. Of the major pests of paddy the paddy thrips, the paddy pentatomid bug, the paddy leaf hoppers and the swarming caterpillar cause the greatest damage to paddy during the seedling stage, while the stem borer damages paddy seriously at all stages of its growth and the paddy bug restricts its damage to paddy grains in the milky stage of development. Field rats especially of the species *Gunomys gracilis* (Nehring), are also important pests of paddy and show a strong preference for paddy stalks in the *heen bundy* stage or for paddy earheads.

The major pests of paddy are responsible for an annually or even biannually recurrent destruction of crop and loss or reduction of harvests. These colossal losses can be avoided by the enforcement of proper crop protection practices among which pest control by the use of chemicals is of outstanding value today. Highly effective chemical control measures, which are practicable locally, have been evolved for the control of all the major pests of paddy with the exception of the paddy stem borer. The types of equipment, best suited to local conditions, for use in the chemical control of paddy pests will be discussed later. A brief review of the life cycles and the nature of damage by the major pests of paddy, together with an account of the chemical control practices found most effective against these pests, will therefore be appropriate at this stage.

Life Histories, Damage and Chemical Control

Paddy Thrips. The adult stage of the paddy thrips is represented by a minute black or brownish black insect about .75 mm. long with clublike wings fringed with long hairs giving this structure a feathery appearance. The young thrips strongly resemble the adults, except that they are yellowish in colour and smaller in size and the wings may be in various stages of development.

The appearance of a paddy field in the advanced stage of thrips attack is very characteristic in that the paddy plants present a scorched appearance and closer examination would show that the older leaves of the paddy plants are brown in colour and dried from the tips backwards, while the younger leaves are green and rolled up longitudinally. If the roll of the leaves is carefully undone, thrips at all stages of development may be seen on the leaf surface. Thrips feed by rasping the leaf surface with their mouth parts and sucking the sap which exudes from the wound caused thereby. In the early stages of thrips feeding the leaf surface shows light yellow streaks where the chlorophyll has been destroyed. As feeding increases the leaves tend to roll up longitudinally and then dry from the tips backwards. This type of damage results either in a severe setback in the growth of paddy plants or, when heavy, in the death of paddy seedlings.

Paddy thrips attack can be detected by routine examination of the seedling crop. At the first indication of the longitudinal rolling of the leaves, thrips attack is indicated and is confirmed by careful examination of the rolled leaves. Recognition of the thrips attack at the later stage when the plants present a scorched appearance will be too late, as by this time the main damage has been done by the thrips. These insects are controlled by dusting the plants with a low percentage gamma benzene hexachloride dust. Dusting with 5 to 10 pounds of 5 per cent. to 65 per cent. gamma benzene hexachloride dust has given very good control of this pest. (Baptist, 1947 a.)

Control of paddy thrips with benzene hexachloride dusts has been carried out for nearly seven years to date. During the last two years there have been reports that paddy thrips are not as easily controlled with benzene hexachloride dust as they used to be. While the possibility that paddy thrips have acquired resistance to benzene hexachloride has not yet been checked in the laboratory this cannot be overlooked. However, sprays of DDT have been found to give complete control of this pest in all cases. With the mist blower, spraying is done at the rate of 1½ gallons per acre. The spray is prepared by mixing 2 pints of a 15 per cent. to 25 per cent. DDT emulsifiable concentrate with water to make 1½ gallons of spray. With the double knapsack boom sprayer the spray is prepared by mixing 2 fluid ounces of a 15 per cent. to 25 per cent. DDT emulsifible concentrate in one gallon of water and spraying the attacked fields at the rate of 10 to 20 gallons of prepared spray per acre.

Paddy Leaf-hoppers and Fulgorids. At least three species of paddy leaf hoppers and one fulgorid are commonly found attacking the paddy plant. *Nephotettix bipunctalis* F. is a small yellowish green leaf hopper but the male has a black spot and a black tip on each wing cover, while *Tettigoniella spectra* Dist. is a larger leaf hopper, pale yellow to dirty white in colour. *Erythroneura subrufa* Motsch is another species of leaf hopper more recently found to damage paddy plants very seriously in shaded areas. This is a small insect with whitish wings and reddish brown head and thorax. *Niloparvata greeni* is a very small whitish fulgorid attacking paddy.

All these insects feed by piercing the plant tissue with their stylet-like mouth parts and sucking up the plant sap.

Paddy leaves attacked by leaf hoppers show small yellowish or whitish streaks that are very clear against the background of green of the leaf. These streaks are located at the points of leaf hopper feeding and are the results of the localized destruction of the chlorophyll. Rarely is a paddy field in Ceylon found without leaf hopper attack.

The life history of all these species of leaf hoppers is similar in that the eggs are laid within the leaf tissue and both the young nymphs that hatch out and the adult leaf hoppers feed by puncturing the plant tissues and sucking the sap.

The presence of these insects on paddy is easily detected either by the streaks of feeding punctures left on the leaves or by disturbing the plants when these insects take to the wing in large numbers. Light attack by these pests only causes streaking of leaves and loss of chlorophyll but when the attack is heavy the streaks become so numerous as to cover almost the entire leaf surface. As a result entire leaves are killed. When this type of attack occurs on seedling plants, usually, death of the plants results. Older plants suffer a severe setback in their growth. These leaf hopper pests are easily controlled either by gamma benzene hexachloride dusts or DDT sprays as recommended for paddy thrips control. However, it should be mentioned that the DDT spray has been found to give the best results. Scutinophara lu

Paddy Pentatomid Bug. This insect has been reported from many parts of Ceylon but has developed into pest proportions chiefly in large paddy tracts under the Walawe Left and Right Bank Schemes near Ambalantota. A fair-sized outbreak has also been recently reported from Okampitiya in the Province of Uva and Kosgoda in the Western Province. Until 1940 this insect was not considered a pest of paddy but in the *maha* of that year it occurred in very large numbers in the paddy areas around Ambalantota (de Alwis, 1941). Since that year outbreaks of this insect have been recurring annually in this area in increasing proportions.

The adult pentatomid bug is a dark brownish or black insect about 10 mm. long and 5 mm. wide. The body is broadly oval in shape and dorsally convex. The eggs of the pentatomid bug are laid in groups on the underside of paddy leaves. The young nymphs which hatch out generally resemble the adults but are lighter in colour and are softer bodied. All stages of the pentatomid bug feed by piercing the plant tissues and sucking the sap. Light damage by this pest results in a setback in the growth of the plants, while a heavy attack by pentatomid bugs repeatedly feeding on the plants results in the death of the plants. The adult bugs are found on the leaves and the stems of the paddy plants, while the younger stages restrict themselves to the bases of the plants up to a few inches above water or mud level. The worst damage is caused to seedling paddy (about two weeks to a month old) to which a first generation of adult bugs migrate from wild grasses. The second generation of bugs breeds on the paddy plants and, unless efficient control practices are enforced, this reaches the adult stage between the *maha bundy* and the early postflowering stage of the paddy plants. At this stage bugs cause considerable damage to the earheads by sucking the young grains dry.

Insecticidal dusts are relatively ineffective against this pest. A very wide series of insecticides have been tested for the control of the pest. This bug is very susceptible to Dieldrin and Lindane, while it is much less so to Aldrin, DDT, Toxaphene and Chlordane. The quickest and the most economical control with very good residual protection of the crop has been achieved with Dieldrin. This insecticide, used in quantities as low as 2 ounces of the actual insecticide per acre, has given complete control of the pest within 12 to 24 hours of treatment. A Dieldrin emulsifiable concentrate formulation containing 1.5 lb. actual Dieldrin per U. S. gallon (approx. 19 per cent. Dieldrin) and a Dieldrin 50 per cent. water wettable powder have been used with equal success although the emulsion has been found to be quicker acting. In preparing the spray either 1 fluid ounce of the emulsifiable concentrate is mixed in 1 gallon of water or 1 ounce of the 50 per cent. water wettable powder is mixed in 2½ gallons of water. Spraying should be carried out at the rate of about 10 gallons per acre, using the double knapsack boom sprayer.

Paddy Swarming Caterpillar. The damage by this pest to paddy is the most spectacular and therefore the most easily recognized type of pest attack. Swarming caterpillar attack of paddy has been a biannually recurring feature in the large paddy tracts, thousands of acres being affected at a time. The plants in affected areas are chewed almost to soil level, and very often in a heavy attack three or more greenish or brownish caterpillars are found devouring each paddy plant. Generally, seedling paddy, three weeks old or more, is attacked by this pest, although occasional attack of older paddy even up to the earhead stage on an extensive scale has been recorded.

The adult of this pest is a brownish moth. The female moth lays her eggs on paddy plants or wild grasses. The caterpillars which hatch out are pale greenish in colour and feed only on the leaf surface. At this stage the caterpillars are seldom noticed, but if major damage to the crop is to be avoided it is essential that the pest is recognized at this stage or even earlier, when the numerous egg masses are found on the leaves, and the appropriate control measures brought into operation immediately. More often than not, however, the pest is recognized when the greatest damage has been done and defoliated paddy plants each carrying one or more voraciously feeding, brown caterpillars are observed. The caterpillars pupate in the soil, so that flooding of the fields where mature caterpillars are present can control the pest, but only after the damage has been done to the crop.

The pest is very easily controlled by sprays of DDT. Any 15 per cent. to 25 per cent. DDT emulsifiable concentrate used at the rate of 2 fluid ounces per gallon of water and sprayed at the rate of 10 to 15 gallons of spray per acre with the double knapsack boom sprayer gives complete control of the pest. Similarly, using the mist blower with a spray prepared by mixing 2 pints of a 15 per cent. to 25 per cent. DDT emulsifiable concentrate with water to make 1½ gallons of spray and spraying at the rate of 1 to 1½ gallons of spray per acre, complete control has been effected within 24 hours. Low volume spraying with the

mist blower is especially advantageous in areas where the caterpillars have retreated into the cracks of mud in the daytime during drought periods and when water transport for the preparation of the spray for large acreages is a problem.

Other leaf-eating caterpillars like the paddy leaf roller, *Marasmia bilinealis*, the paddy case bearer, *Nymphula depunctalis*, the Borolia caterpillar, *Boralia venalba*, and caterpillars of the genus *Parnara* are also effectively controlled by the sprays found to give complete control of the swarming caterpillar.

Paddy Bug. The pest is commonly found in areas where paddy is maturing. When no paddy is available for food the paddy bug is found feeding on wild and other cultivated grasses. The paddy bug damages the crops by sucking the juice of the young grains in the milky stage. This pest is islandwide in its distribution and where it exists is responsible for the loss of anything between 1 per cent. to 100 per cent. of the harvest. Where destruction of the earheads by this pest is extreme, it often becomes uneconomical to harvest the crop which is then ploughed under instead.

The paddy bug is very susceptible to the action of DDT dusts and benzene hexachloride dusts (Baptist, 1947 a and b) of very low gamma isomer content (.5 per cent. and above). Used at the rate of 5 to 10 lb. of dust per acre of paddy this insecticide has given complete control of the pest. In the last two years there have been increasing reports of the difficulty of controlling the paddy bug with benzene hexachloride dusts. While there is the strong suggestion that the pest is developing resistance to benzene hexachloride this has yet to be tested. Aldrin 2½ per cent. dust gives good immediate control of this pest but reinfestation of treated fields by the bugs occurs between 3 days and a week after dusting. This does not usually occur in benzene hexachloride-treated areas. The DDT spray recommended for paddy thrips control has also been found very effective against the paddy bug. Schoenobis ⊕ bipunctifer

Paddy Stem Borer. This insect is the most serious pest of long-aged paddies in the Western and North-Western Provinces. The adult of the stem-boring caterpillar is a small yellow to brownish-yellow moth with two characteristic black spots at the posterior ends of the two fore wings. Female moths lay their eggs in masses on paddy leaves. The minute caterpillars which hatch out gradually feed their way into the paddy stems. Here they feed on the internal tissues of the stem and by the time these caterpillars have reached maturity they have worked their way to the base of the plants. Mature caterpillars pupate within the paddy stems and emerge as moths from the stems to repeat the cycle of damage to the crop. The entire life cycle lasts 1½ to 2 months so that on long-aged paddies at least two generations of stem borers can damage the crop.

Younger paddy plants attacked by the stem borer invariably die. The initial symptoms of damage by the stem borer or the paddy stem fly (*Atherigona* sp.) in young paddy are the yellowing or browning and subsequent death of the central growing shoot, and only dissection of the paddy plant will show

whether the maggot of a stem fly or a caterpillar of the stem borer is the cause, although minute entrance or exit holes on the stem of the attacked plant will indicate the latter. Attack of younger paddy plants by the stem borer therefore results in a reduction of the number of tillers. Paddy attacked by the stem border in or after the *heen bundy* stage produces characteristic white earheads with empty grains.

Workers in Japan (Hajime Suenaga and Bunji Hashizume, 1953, and Kisabu Iyatomi, 1952) have found that sprays of organophosphorus insecticidal preparations containing parathion give satisfactory control of the rice stem borer in Japan. Parathion is an insecticide which has a high mammalian toxicity rating and therefore presents serious hazards to users unless certain precautions such as the wearing of protective clothing, respirators, etc., are rigidly enforced. As it is felt that, at present, the Ceylonese paddy cultivator is in no position to use organophosphorus compounds without serious mishaps, parathion products are not being recommended for stem borer control in Ceylon.

Recent reports from the Philippines suggest that a relatively safer insecticide belonging to the chlorinated hydrocarbon group and known as Endrin has given good control of the paddy stem borer. A series of insecticides including Endrin are being tested in our investigations being carried out currently on the control of the paddy stem borer. Until the results of these investigations are available, therefore, no specific recommendations for the chemical control of the paddy stem borer will be made.

Paddy Field Rats. Rats, particularly of the species *Gunomys gracilis,* often cause extensive damage to paddy in tracts where they occur. Usually paddy in the *heen bundy* stage and after is most susceptible to attack by rats. These rats feed on the basal parts of the paddy plants, and the earheads of mature paddy are either consumed in the field or stored by these rats in their burrows located on the bunds or at the borders of the paddy tracts (Phillips, 1935). Paddy *liyaddas* attacked by these rats are easily distinguishable by the fact that plants are scanty or wanting at the centre of the *liyaddas* where the rats tend to concentrate their feeding.

Field trials with the rodenticide Warfarin, which is a hydroxy coumarin derivative, have proved that baiting with this cumulative poison gives control of the pest within 6 days to two weeks of the commencement of baiting. At the first signs of rat activity in paddy fields, indicated by the presence every morning of increasing numbers of withering paddy plants cut at the bases, baiting with a Warfarin preparation should be commenced.

A 1 per cent. Warfarin preparation is mixed thoroughly with maize meal at the rate of 1 part of the 1 per cent. Warfarin formulation in 29 parts of the maize meal. The attractiveness of the bait to the rats is enhanced by the addition of a little roasted shredded coconut or dried sprats heads. Approximately two-ounce portions of this bait are placed inside a (cylindrical) piece of bamboo about one foot long and six inches in diameter, prior to distribution in rat-infested paddy fields. About ten to fifteen such baits are laid late in the evening to each acre of attacked paddy

field. The baits should be inspected every morning and replenished where required. No pre-baiting with non-poisoned baits has been found necessary as the rats do not avoid baits after the first feeding. A minimum of four days feeding by rats is required before fatal effects are observed, as Warfarin is a cumulative poison. Almost with the commencement of baiting a decrease in the number of cut paddy stalks is observed. By the end of the fourth or fifth day of baiting the mortality of rats is confirmed by the presence of dead or dying rats in the fields. Baiting should be continued until the destruction of the rat population is confirmed by both the absence of attack on the paddy plants and by the untouched baits in the field. A paddy area baited with Warfarin nearly two years ago has not yet been reinfested by rats.

Discussion

Most of the major pests of paddy can be very effectively controlled by the use of chemicals. In the great majority of cases of large-scale paddy pest control in Ceylon to date, however, the pest has already done its damage before control operations have commenced. As a consequence much of the intrinsic value of the control of the pest is lost and the operation has defeated its purpose. The reason for this is the ignorance of the cultivator who seriously recognizes the necessity for action only when the pest has built up into epidemic proportions and the damage to the crop is glaringly obvious. An economic return for an investment in all-out pest control operations can only be obtained if such operations are so timed as to control the pest before the damage has been done. This can only be achieved by routine crop inspection and the timely recognition of the existence of pests which are potentially capable of causing considerable damage to the crop. *Much of the crop losses due to the ignorance of plant pests and diseases and their control on the part of cultivators will be eliminated shortly with the intensification of extension activities of the Department of Agriculture through the newly formed Plant Pests and Diseases Extension Service.*

Of all the methods of pest control at the disposal of the cultivator today, those by the use of chemicals have proved to be the cheapest and the quickest and have provided the most spectacular results. The cost of insecticides required to control any of the paddy pests mentioned, on one acre of paddy, ranges between Rs. 2 and Rs. 4, and the time required to treat such an acre of paddy with the insecticide ranges between 15 minutes and two hours, depending on the type of equipment used. The cost of labour and chemical to treat one acre of paddy, say against the swarming caterpillar, would not therefore exceed Rs. 6, which is really the price of half a bushel of paddy at the current guaranteed price. In terms of increased or protected harvests the investment in chemical pest control methods therefore pays very heavy dividends.

The relative ease, cheapness and the rapidity of achievement of results of pest control by the use of chemical have discouraged to a large measure the enforcement of numerous valuable cultural practices designed for effective pest control. The importance of practices

such as the avoidance of overlapping cultivations to prevent the build up and perpetuation of large pest populations, the proper timing of planting seasons so as to reduce the likelihood of pest attack, the enforcement of clean weeding and transplanting to reduce the alternate host plants of paddy pests within paddy tracts, the flooding of pest-attacked paddy tracts where a stage of the pest survives near or in the soil at the base of the paddy plants, the burning of the stubble and the exposure of the fallow land to the direct action of sunlight, cannot be over-emphasized. For example, large numbers of pupae of the paddy stem borer are found in the stubble of paddy plants after harvest, while the pentatomid bug is found to survive between cultivations in the moist soil beneath the lodged stubble in harvested paddy tracts. This enormous carry-over of both stem borers and pentatomid bugs can easily be destroyed by the simple practice of burning the stubble, and the labour and expense on chemical control operations thereby reduced or avoided.

No general account of the control of a group of pests by the use of chemicals will be complete today without the mention of the development of insecticide-resistant strains of insect pests. To date there are only unconfirmed reports suggesting the development of resistance to insecticides by local agricultural pests. These refer to the possible development of resistance to gamma benzene hexachloride by the paddy bug and the paddy thrips among the agricultural pests in Ceylon. These reports cannot be discredited in view of the fact that numerous insect and other arthropod pests both of agricultural and of medical importance have been definitely found to have developed an alarming degree of resistance to modern organic insecticides (Babers and Pratt, 1951). Recently a species of leaf hopper, *Erythroneura variabilis* Beamer, attacking grape vines in California and closely related to a local paddy leaf hopper of the same genus, *E. subrufa* Motsch, has been recorded to have acquired resistance to DDT within five years of its use to control this pest (Barnes *et al.*, 1954). There is every indication therefore that if resistant strains of agricultural pests have not already developed in Ceylon it will not be long before such strains are developed, particularly with the intensification of the food production drive and the concomitant intensification in chemical pest control practices.

The development of immunity or resistance to antibiotics by strains of pathogens responsible for human or animal diseases has in no way reduced the use or value of these drugs to medical science. On the other hand it has introduced a note of caution and greater discrimination in the use of the drugs while at the same time stimulating more intensified research in this field of work. The appearance of insecticide resistant strains of insect pests has stimulated the same trends in the field of chemical control of insects. Intensified research in this field may in the future provide the crop protection worker and the cultivator with newer and more potent pesticides, highly efficient activators or synergists for the older pesticides, and even highly specific and efficient insect attractants and repellants.

II Equipment for Insecticidal Treatment of the Paddy Crop

Introduction

THE development of pest control techniques on the paddy crop by the use of insecticides has formed a major segment of the activities of the Division of Entomology in recent years. All the modern organic insecticides have proved inherently toxic in one way or another to the insect pests attacking paddy in Ceylon. However, the chief problem on the insecticidal control of paddy pests has been the availability of suitable spraying and dusting equipment for treating the paddy crop conveniently and economically so as to give maximum pest control results. Factors such as the wet nature of the cultivation of paddy, the wide variability of the terrain on which the crop is grown, the variability in size of the tracts under paddy cultivation, and very often the inaccessibility of these tracts by way of good roads, have presented major handicaps to an easy and straightforward solution of this problem. However, after over two years screening of various types of equipment we are in a position to record some progress in this field of work. In this section therefore an attempt will be made to describe the equipment being currently used in Ceylon to treat paddy with insecticides and also to survey critically their various features with particular reference to their value to the Ceylonese paddy cultivator.

Heavy Power-driven Equipment

Heavy power-driven, tractor-drawn sprayers or dusters cannot possibly perform on boggy paddy fields. The other alternative in the line of heavy power-driven equipment would be the use of a heavy power unit with a spray tank borne on a stretcher arrangement which could be operated from the borders of paddy tract. Long spray hoses equipped with single or multiple nozzles leading from the power unit could then be used to deliver the spray fluid on the paddy crop. In this case too the use of such equipment would be limited by the terrain and the accessibility of the paddy tract. Furthermore, as bulky equipment cannot be transported within a paddy tract, the area that could possibly be treated by this equipment would necessarily be limited by the length of the spray hoses leading from the power unit at the boundary of the paddy tract. Under these circumstances therefore we have been limited in the choice of equipment either to (*a*) that operated from aircraft, or (*b*) light hand-operated or power-driven equipment which could be operated while slung on the shoulders of an operator.

Spraying by Aircraft

Tests have been carried out on aerial spraying of paddy tracts, using fixed wing aircraft. The aircraft used was an Auster belonging to the Ceylon Air Academy and flown by pilots of this organization specially trained in aerial spraying. The spraying rig installed in the plane was supplied by the Shell Co. of Ceylon, Ltd. This spray rig was of the usual type used in aircraft spraying in other countries, consisting of a 30-gallon spray tank installed in the back cockpit of the plane, a small windmill propeller on one of the lower wings to drive the pump which provides the low pressure required to direct the spray fluid into the spray booms, one of which lies parallel to each wing of the plane.

Each spray boom was equipped with several nozzles and atomization of the spray fluid depended on the air blast around the nozzles during the flight of the plane.

Section of the Auster aircraft used in aerial spraying, showing (*a*) the spray tank, (*b*) the spray boom, and (*c*) spray nozzles

Crop spraying by aircraft was carried out for the first time in Ceylon last year when large tracts of paddy at Polonnaruwa and Minneriya were attacked by the paddy swarming caterpillar, *Spodoptera mauritia*. Between two and three gallons of spray fluid (two pints 18 per cent. DDT emulsifiable concentrate with water to make 1½ gallons of spray) were used per acre, spraying being done by the plane flying 8 to 15 ft. above the field. About 40 acres of paddy were sprayed by this method per hour. This period included time taken for refuelling, refilling of spray tanks and flying 6 to 8 miles each way from airfield at Hingurakgoda to the area being sprayed. This method of treatment was, as would be expected, extremely rapid, and gave 100 per cent. control of the pest. It also eliminated the usual damage to crop caused by spray operators walking through the paddy fields during ground operations.

Aerial spraying in Ceylon while being practical and economical will, however, be limited by two factors which are (*a*) the availability of large continuous tracts of paddy which are relatively flat, and (*b*) the presence of satisfactory airstrips in the immediate neighbourhood of these large paddy tracts. At present large paddy tracts, of the type where aerial spraying is feasible, exist in the North-Central, Eastern and Southern Provinces. However, an airstrip close enough to the paddy tracts exists only in the North-Central Province at Hingurakgoda. If aerial spraying is to play a larger part in paddy pest control, it is essential that a sufficient number of small airstrips be constructed in the immediate neighbourhood of the large paddy tracts in Ceylon. The construction of small airstrips in Kalmunai and Ambalantota immediately will prove of great value for rapid pest control on the large tracts of paddy in these areas.

Ground Equipment—Dusters

Until recently the only type of duster employed was the simple *Rotary Hand Duster*. Where these were not available the insecticidal dust was applied by shaking it in muslin bags at the end of a stick over the crop. The rotary hand duster is still the chief machine used for dusting paddy. But it is of special value only when used to treat small acreages of paddy. Up to 15 acres of paddy can be treated per day with one rotary hand duster. Speed in application of insecticidal control measures against the paddy bug, against which dusting is chiefly done, is of crucial

importance if damage to grain is to be minimized. In the case of infestations of the paddy bug on large acreages therefore a machine of high efficiency as a duster is required. A machine of this type has been tested recently and found to be ideally suited for dusting large acreages of paddy in the shortest possible time.

This duster, known as the *B. S. E. Junior Power Duster* manufactured by Bernhard Schulze Eckel of Ahlen, Germany, was brought to our notice and loaned for testing by Messrs. Chatham House Ltd., Colombo. It weighs about 41 lb. when filled with dust. It is powered by a 2-stroke engine and carries a dust hopper which can contain up to 15 lb. of dust. When slung on the shoulders of an operator the power machinery and dust hopper lie on the operator's back. Two levers operated by the operator's left hand can control the output rate of the dust and distance of propulsion of the dust. The outlet hose for the dust is manipulated by the operator's right hand. Between 50 to 75 acres of paddy can be treated per day, using a single machine of this type. The price of this duster (about Rs. 750) places it outside the range of likely purchase by individual cultivators. However, its high efficiency rating as a duster, and the important saving in time and labour in its use in large-scale operations as compared to the rotary hand duster, point to its being of value if stocked by C. A. P. & S. Societies or other central organizations for hiring and use by cultivators. Aerial dusting of paddy has not yet been tried out. However this method of dusting crops is practised in other countries and will be introduced into Ceylon shortly.

Dusting paddy with a rotary hand duster

Close-up of dusting paddy with the power duster

Ground Equipment—Sprayers

The greater emphasis has been placed in our work on the evaluation of spraying equipment in view of the fact that, in most cases of paddy pest control, residual insecticidal action is the aim. Many types of sprayers have been tested and each type has been found to be suited

to a particular need and has its inherent advantages and disadvantages. The sprayers tested were the Knapsack sprayer, the Mist blower, the Knapsack boom-sprayer, and the double Knapsack boom-sprayer.

The Knapsack Sprayer. When spraying of the paddy crop was first undertaken the chief type of sprayer available was that of the Knapsack type. The Knapsack sprayer while being suitable for treatment of small holdings of paddy is of little value when large-scale operations in pest control have to be undertaken. A spray operator can spray up to 3 acres of paddy per day using a Knapsack sprayer. A volume of spray liquid ranging between 40 and 50 gallons is required per acre when spraying with the Knapsack sprayer. Apart from the high volume of spray liquid required per acre the Knapsack sprayer has the disadvantage that the operator's limbs are continually exposed to the spray liquid during sprayings, a feature which has to be given special consideration from the spray hazard standpoint. This would tend to limit the choice of insecticides to be used with the Knapsack sprayer.

The Mist Blower. A power-driven, low-volume sprayer known as the mist blower was brought to our notice by Mr. Peter Van Bemmel of the Royal Dutch Shell Laboratory and Mr. John Corbould of the Shell Co. Ltd., Colombo. The machine was still in the prototype stage and was being tested and developed by Mr. Van Bemmel for low-volume spraying of copper fungicides against the blister blight fungus of tea. This machine is at present manufactured by J. Duiker & Co., The Hague, Holland. The mist blower weighs about 56 lb. when the spray tank is full. It is powered by a two-stroke engine which operates

Spraying paddy with the mist blower

the high revolution rotary fan by way of a clutch and cable mechanism and also provides the pressure for the spray tank. The spray tank is equipped with non-return valves and safety valves for pressure release. The spray tanks (2 connected tanks per machine) carry 1½ gallons of liquid when full. The spray fluid leads from the spray tanks by way of plastic rubber tube into a low-volume hollow-cone nozzle placed at the axis of the rotary fan. The spray fluid leaving the nozzle at a pressure of about 80 psi is further atomized and propelled by the air blast provided by the rotary fan. When slung on the back of the spray operator the two-stroke engine and the clutch mechanism for the fan cable lie on the back of the operator, while the spray tanks lie on the chest of the operator. The spray operator can control the direction of the spray by means of a semicircular handle on the fan casing which is suspended in front of him.

The spray which leaves the nozzle in the form of a scarcely visible mist, is

directed horizontally in the direction of the wind and good coverage of paddy is obtained over an area of about 6 feet wide extending up to 20 feet away from the nozzle under still conditions, while coverage may extend even to 30 feet from the nozzle under strong wind conditions. Spraying is carried out in parallel tracts of 20 to 30 feet wide. Concentrate sprays of the emulsion type are normally used with this machine. However, wettable powder suspensions may be used but some shaking of the spray tank is needed during operations as no agitator mechanism is found in the tank. Between 1½ and 2 gallons of concentrate spray is required per acre of paddy for good coverage with the mist blower. A maximum of 25 acres of paddy can be sprayed per day with a single mist blower. This machine has proved invaluable during the last year for paddy pest control operations. Summarized, the advantages of the mist blower in paddy pest control may be listed as follows :—

(i) It is easily manipulated by a spray operator without causing any discomfort during operations regardless of terrain.

(ii) The volume of spray liquid required for complete coverage of an acre of paddy is extremely low—in fact the lowest volume per acre within practical limits —so that the transport and supply of large volumes of water for preparation of spray fluid is not a problem.

(iii) The rapid rate of treatment of paddy.

(iv) The complete coverage of the paddy plant by the spray and the excellent pest control results obtained.

Against these advantages the mist blower has some disadvantages which may be listed as follows :—

(i) The spray nozzle being directly in front of the spray operator, the latter is exposed to the hazards of the insecticidal spray both by inhalation and by skin contamination. This is especially so on days when unsteady wind conditions prevail. As the sprayer is of the low-volume type and insecticidal concentrate sprays are necessarily used, this hazzard to a large extent limits the range of chemicals to be used with it. The use of respirators, goggles, helmets and appropriate clothing will, however, to a large extent offset much of the hazards to the operator arising from this source.

(ii) The complexity of the machine requires that it be mantained and operated by well trained operators or by cultivators under the supervision of trained operators.

(iii) Being a machine dependable on the high revolution rates of its parts, wear and tear on certain parts is heavy.

(iv) The cost of the machine is high and therefore can only be purchased by central pest control organizations or C. A. P. & S. Societies and not by cultivators.

The Knapsack Boom Sprayer. A spray boom operated by Knapsack sprayer has been developed in this laboratory. It consists of a Knapsack sprayer, to the back face of which is welded two vertical metal rods. An 8-foot, 8-nozzled

brass boom is maintained 3 feet behind the Knapsack sprayer by way of an aluminium framework attached by clamps to the two vertical rods on the Knapsack sprayer. The height of the spray boom from the ground, when the Knapsack sprayer is slung on the shoulder of an operator, can be varied according to the height of the crop by sliding the clamps along the vertical rods. A Knapsack sprayer of the type commonly used is capable of maintaining eight low-volume hollow cone nozzles in efficient operation. The main defect of this sprayer is that it is unwieldy and tends to overbalance backwards. The greatest advantage of this sprayer, which cannot be claimed by most other types of sprayers, is that the spray operator never walks through the sprayed areas. Spraying is always done in ten-foot-wide parallel tracts with the boom about 3½ feet behind the operator. These features are of special value to Ceylonese cultivators when considering the fact that footwear is never worn during operations and that protective clothing of any type is generally wanting. In view of some of the uniquely advantageous features of this sprayer efforts are being made to rectify the poor balancing while preserving the salient features of the machine.

The Double Knapsack Sprayer. A sprayer of this type was supplied to us for testing purposes by Messrs. Four Oaks Spraying Co. of Birmingham, England. This sprayer consists of a 9-foot, 8-nozzled brass spray boom, to either end of which the spray hose of a Knapsack sprayer is connected. The nozzles are of the low-volume hollow cone type. The spray boom is supported by an aluminium framework to either end of which is attached a handle.

In operation each Knapsack sprayer is slung on the shoulder of an operator who controls the pressurizing lever of the sprayer with one hand and maintains the spray boom at the required height above the crop with the other hand. Tests with this type of sprayer have shown that good coverage of seedling paddy is obtained when spraying is done at 10 gallons per acre. Older paddy growing under boggy conditions require up to 18 to 20 gallons of spray fluid per acre. The capacity of each Knapsack sprayer is 3 gallons so that in spraying an acre of seedling paddy with the double Knapsack boom sprayer, refilling

Double Knapsack boom sprayer being used to spray paddy seedlings in a nursery

will have to be done once on the field. On the other hand if a single Knapsack sprayer were used with a spray lance, up to 40 gallons of spray would be required per acre and refilling of the sprayer will have to be done at least 12 times to cover one acre of seedling paddy. Using the double Knapsack boom sprayer up to 20 acres of paddy can be sprayed per day. A Knapsack sprayer used without the boom can spray only 3 to 5 acres of paddy per day so that it is decidedly advantageous to use Knapsack sprayers with the spray boom instead of alone. The only disadvantage of this type of sprayer, which is also true of Knapsack sprayers used alone, is that one of the two spray operators handling this spray unit walks over sprayed areas on alternate parallel sprayed tracts during spraying operations. If there is sufficient water in the field, however, any hazard from this source is greatly minimized.

Apart from the important features of this spray unit like the low volume of spray liquid required per acre, the large number of acres sprayed efficiently per day by a single spray unit ; the good pest control results obtained and the ease of operating it, the simplicity of this equipment together with absence of serious maintenance problems makes it ideally suited for use by Ceylonese paddy cultivators. Cultivators can be trained in a few hours to operate and maintain the double Knapsack boom sprayer and any repairs to the sprayer can easily be handled by a village blacksmith.

Summary

(i) The various types of hand operated and power driven sprayers and dusters tested and found to be of value for the insecticidal treatment of paddy, have been described and details of their performance presented.

(ii) The value of each type of machine to the cultivator has been critically appraised from the standpoint of cost, efficiency, simplicity of mechanism and ease of maintenance.

(iii) The role of aircraft in paddy pest control in Ceylon is discussed and steps are suggested for the future development of this method of pest control.

(iv) The double Knapsack boom sprayer and the rotary hand duster are the best machines for maintenance and use by paddy cultivators while the mist blower and the light power duster are best suited for use by central pest control organizations on account of their relatively high cost and maintenance requirements.

The mention of specific makes of machines in this article should in no way suggest that these machines alone are recommended for purchase and use locally. The machines mentioned only represent certain equipment types and similar machines of other makes will prove equally efficient in paddy pest control under local conditions.

Acknowledgments

The authors express their indebtedness to the Royal Dutch Shell Laboratory, Delft, Holland, for the expert services of Mr. Peter Van Bemmel in connection with the Duiker mist blower, to the Shell Co., Ltd. of Ceylon for the co-operation of Mr. John Corbould on many occasions, to Messrs. Four Oaks Ltd., Birmingham, England, for the loan of a double Knap-

sack boom sprayer and to Messrs. Chatham House Ltd., for the loan of a B. S. E., Junior duster for testing. The achievement of Capt. C. H. S. Amerasekera of the Ceylon Air Academy and his staff who pioneered aircraft spraying of paddy in Ceylon is recorded.

Bibliography

BABERS, F. H., and PRATT, J. J., JR. 1951. Development of insect resistance to insecticides, II. A critical review of the literature up to 1951. *U. S. Bur. Ent. and Plant Quar.* E-818, 45 p. Ref. May 1951. 1.9. En 83.

BAPTIST, B. A., 1947 a. Annual Report of the Director of Agriculture for 1947. *Ceylon Government Press :* 10.

BAPTIST, B. A., 1947 b. The possibilities of utilization of DDT and Gammexane for plant protection in Ceylon. *Trop. Agric. (Ceylon)*, Vol. 103, No. 1 : 12-19.

BARNES, M. M., FLOCK, R. A. and GARMUS, R. D., 1954. Resistance to DDT by the grape leaf hopper, *Erythroneura variabilis* Beamer. *J. Econ, Ent.*, Vol. 47, No. 2 : 238–241.

DE ALWIS, E., 1941. The paddy pentatomid bug Scutinophara (Podops) lurida Burm. *Trop. Agric. (Ceylon)*, Vol. 96 : 217-220.

IYATOMI, K., 1952. Preliminary experiments on systemic insecticides against rice stem borer. *Shizuoka Agric. Expt. Sta. Pamphlet*, 1952, Tokio, Japan.

PHILLIPS, W. W. A., 1935. *Ceylon Journal of Science, Manual of the Mammals of Ceylon.* 253-256.

SUENAGA, H., and HASHIZUME, B., 1953. *Bull. Kynshu Agri. Expt. Sta.* 1953, 336.

Plant Disease and New Development Schemes

J. W. L. PEIRIS

RECENT years have seen the steady increase in the number of new development schemes in various parts of the island. Conceived and inaugurated by the late Right Hon. D. S. Senanayake, as the first Minister for Agriculture, the oases of cultivated crops which dot the landscape of the dry zone today bear testimony to the success of his venture of wresting cultivable agricultural land from the jungle. The far sighted policy of this great agriculturist has not only sought to revive Ceylon's noble agricultural heritage of the past but was founded on 'a deep knowledge of the realities of our contemporary situation'.

Some of the new development projects bring into cultivation land which has been permanently under jungle while others seek to reclaim land which was once cultivated but had been abandoned centuries ago. The Galoya project alone is expected to irrigate 90,000 acres reclaimed from the jungle. The Parakrama Samudra scheme will bring again under cultivation 54,000 acres. With other great works at Kalawewa, Ridibendi Ela, Minipe Ela, Walawe, Nilwala Ganga, &c., a total extent of 131,000 acres are expected to be brought under cultivation according to the six year plan. (A six year plan for Ceylon—J. R. Jayewardene).

Land which is newly won from the jungle or reclaimed after centuries of abandonment is free from the many common diseases which the cultivated crops are heir to. Not only is the soil unlikely to harbour the various fungal, bacterial and eelworm populations that commonly thrive on cultivated crops but even the weeds and other plants in these areas to a great degree are free from these introduced diseases. The position, therefore, is that having as we do fresh cultivable areas largely free from disease, should we through carelessness or neglect allow this virgin soil to be quickly contaminated with the commoner diseases which are endemic in the continuously-cultivated areas of the island ?

In plant diseases as much as in human or animal diseases the statement that prevention is better than cure holds true. Indeed it is all the more so of certain plant diseases for which adequate control measures are either unavailable, and are impracticable or expensive. Prevention in these cases should, therefore, receive the greatest consideration. Moreover, the time, expense and labour required to control a disease once it becomes established is certainly far greater than the efforts expended on its prevention.

Among the more important of the diseases which can very easily be prevented from entering new development areas are the Bunchy top disease and the Panama disease of plantains. These two diseases constitute the most important diseases of plantain in Ceylon and in fact, its other pests and diseases are of negligible consequence. Bunchy top disease is a specialized disease and no other alternate host is known for it except Manila hemp

which is hardly grown in Ceylon. The only means possible for its introduction into new isolated areas like the major development schemes is the planting of infected suckers. The same applies to the Panama disease which is caused by a fungus and can only be transmitted in planting material. If infected suckers are prevented from entering the area there is no reason why these two diseases could not be completely excluded from any new development scheme. It is very likely that as the colonists move on to their new homes they would bring with them planting material such as plantain suckers from their previous cultivations. It is here that the danger lies. One approach to this problem is a system of examination of all plantain suckers brought in and their preliminary growth in a quarantine station outside the limits of the colony. Another possibility is the establishment of a disease-free nursery of certified plants from which the requirements of the colonists could be met.

A number of virus diseases causes considerable loss in our cultivations. Tobacco mosaic is common wherever tobacco is grown. In the Hingurakgoda area where Tobacco came to be grown comparatively recently, the mosaic disease is very much less prevalent, than in other areas where tobacco has been grown for a longer time. This is one of the diseases which should be prevented from getting established in a colony as it is capable of attacking a large number of plant varieties. The leaf-curl virus complex of tobacco, chilli and tomato annually takes heavy toll of our crops. Although weeds are alternate hosts for this group of virus diseases—and they are found in abundance in the newly cleared areas—they have hardly been observed to suffer from these diseases. Chance introduction of infected plants would be the stepping stone to the establishment of these diseases in the crops and alternate hosts in their new home. In as much as this virus complex is not known to be transmitted in the seed, the prevention of the introduction of tomato, tobacco, brinjal seedlings, &c., from outside into a new colony should, therefore, form a very effective measure for the prevention of the disease.

The case of the bean mosaic virus group is slightly different. In some of the dry zone areas which have been under cultivation for a long time, e.g., at Maha Illuppallama and Minneriya, various strains of the bean mosaic virus are already in evidence in dhal, cowpea, dwarf bean, French bean, soya bean, &c., as also in certain weeds like *Phaseolus lathyroides*. Unlike the leaf curl complex, bean mosaic is transmitted in the seed. Therefore the use of seed from disease-free crops becomes most important. In a number of cases imported seed has been seen to carry the disease and, therefore, in addition to the use of clean seed stocks, constant vigilance has to be exercised to detect and destroy any plants showing the first symptoms of the disease. To the foregoing number of virus diseases may also be added the mosaic disease of bandakka (*Hibiscus esculentus*) which has become a problem in areas where it has become established, mosaic of cucurbits which infects cucumber, snake gourd, luffa, pumpkin, mosaic of sweet potato, &c.

Among the fungal, bacterial and eelworm plant pathogens there are many common diseases, the prevention of the entry and establishment of which would

be worth a great deal of trouble. Citrus scab caused by a fungus and citrus canker caused by a bacterium can only gain entry to a new area with infected plants. These and bacterial leaf spot of betel, bacterial wilt of tomato, and soft rot of ginger can only be brought into virgin areas by the transport of infected plant material from outside and could be prevented if proper precautions are adopted.

There are, however, a number of plant diseases which do not admit of such comparatively easy methods of prevention. The blast, *Helminthosporium* and foot-rot diseases of paddy are cases in point. Owing to the large amount of seed required for the raising of a paddy crop even one infected seed in a thousand bushels is potentially capable of establishing infection in an area. The same is true of the smut of sorghum. In other cases the detection of a pathogen in a sample of planting material is difficult and may easily escape notice as, for example, the eelworm disease of vegetables.

The extent to which a new area is capable of being preserved from infection by the commoner plant diseases depends on its proximity to older-established cultivations. It is in areas which are sufficiently removed from permanent cultivation that the greatest scope for the exclusion of plant disease obtains. In either case, however, while everything should be done to discourage the colonists from bringing in infected plant material to their new development areas, careful vigilance should also be exercised to take prompt control measures whenever a disease new to the area has appeared. Early and even drastic control measures including the destruction of a crop becomes justifiable if there is a possibility of preventing the establishment of a disease in the colony.

In actual practice it will be found that regulations alone will not bring about the desired effected in preventing the introduction of disease in planting material into a new area. The establishment of disease-free nurseries in the colony is indeed the best approach to this problem. The planting material—whether it be of cereals, plantain, legumes, betel, &c.—obtained from outside the area should be selected disease-free and this could be multiplied within the development scheme with all the necessary precautions to eliminate plant diseases. The seed material could thus be multiplied within the unit and can be made available for planting within the development area. As the area expands, further planting material is available from the clean crops produced by the colonists themselves. Such a scheme and the necessary instruction to the cultivators of the recognition, prevention and control of plant diseases should go a long way to prevent the clean pages of new agricultural activity in our development schemes from being prematurely blotted by plant diseases.

Studies in the Fertilizer Response of Rice

I Direct, Residual and Cumulative Effects of Various Phosphatic Fertilizers

M. F. CHANDRARATNA and L. H. FERNANDO

PHOSPHATE availability in water-logged rice soils is markedly higher than in upland soils largely on account of its occurrence in the more soluble ferrous form. All rice-growing countries, however, except perhaps India, have recorded striking and extensive responses to phosphate. Ignatieff (1951) provides an excellent summary of results obtained in various countries.

In Ceylon, phosphate response in rice has been the subject of investigation by Joachim and co-workers, and the view has been expressed that phosphoric acid is the chief factor limiting yields in Ceylon rice soils (Haigh and Joachim, 1933). In trials set down by Haigh and Joachim (1933) at Peradeniya, in the *maha* (north-east monsoon) season, superphosphate (112 lb./acre) and wide-ratio ammonium phosphate (96.5 lb./acre) gave increases in grain yield of 490 lb. (31 per cent.) and 960 lb. (60 per cent.) respectively over the unfertilized control. The two phosphate dressings had the same P_2O_5 content, and the superiority of ammonium phosphate may be interpreted as a nitrogen response. Records in the following *yala* (south-west monsoon) season, revealed no significant residual effect of the phosphate applications.

Using mixtures equivalent in their nitrogen content, Haigh and Joachim (1935) noted no significant differences between steamed bonemeal, ammonium phosphate, superphosphate and mineral phosphate. They also observed that it was immaterial whether ammonium phosphate was applied in a single dose at transplanting or split in three doses at transplanting, flowering and half-ripeness. The present communication reports subsequent investigations on the immediate, residual and cumulative effects of a range of phosphatic fertilizers.

Table I—Analyses of Phosphates

Material	*Total P_2O_5%*	*P_2O_5% soluble in 2% Citric Acid*	*CaO%*	*MgO%*
1. Superphosphate	18	18	27	0·5
2. Saphos	29·5	—	—	—
3. Hyperphosphate	27	26	47	1·2
4. Magnesium phosphate	19	19	19	14
5. Ammophos	20	20	0·5	—

Forms of Phosphate

The fertilizers tested are listed in Table I.

Saphos is a hard, fluorine-containing rock phosphate from Safaga, Egypt. Hyperphosphate is a highly pulverized, soft, North African sedimentary phosphate ; 90 per cent. passes through a 300-mesh sieve. Nearly 30 trace elements, including boron and molybdenum, have been identified in hyperphosphate. Magnesium phosphate is the product of the fusion of olivine and phosphate rock. The narrow-ratio ammophos (monammonium phosphate plus ammonium sulphate) which was used contained 16.5 per cent. N.

Experimental Methods

Two series of experiments conducted in the *maha* (north-east monsoon) and *yala* (south-west monsoon) seasons, viz., one at the Central Rice Research Station, Batalagoda, and the other at the Rice Research Station, Tissamaharama, are reported herein.

The Batalagoda soil is light-textured and poor in phosphoric acid and nitrogen. The soil at Tissamaharama is a light, grey-brown loam of pH 7.2 deficient in nitrogen, phosphoric acid and potash. Drainage at both centres is satisfactory.

In both series, the fertilizer dressing was made in one of the following three ways :

(*a*) Half dose in each season, *yala* and *maha*.
(*b*) Full dose in *yala*, none in *maha*.
(*c*) Full dose in *maha*, none in *yala*.

Direct effects are, of course, assessed in the season of application. Mode of application (*b*), for instance, estimates direct effects in *yala*, and residuals in *maha*.

The fertilizers were broadcast a few hours before transplanting. The experimental area received no basal dressing, and the nurseries were unmanured.

The Batalagoda Series.—The following 13 treatments were replicated in four randomized blocks :

Treatment No.	*Form of Phosphate*	*Rate*	*Mode of Application*
1	Hyperphosphate	111 lb./acre	(*a*)
2	Hyperphosphate	111 lb./acre	(*b*)
3	Hyperphosphate	111 lb./acre	(*c*)
4	Saphos	102 lb./acre	(*a*)
5	Saphos	102 lb./acre	(*b*)
6	Saphos	102 lb./acre	(*c*)
7	Superphosphate	167 lb./acre	(*a*)
8	Superphosphate	167 lb./acre	(*b*)
9	Superphosphate	167 lb./acre	(*c*)
10	Magnesium phosphate	150 lb./acre	(*a*)
11	Magnesium phosphate	150 lb./acre	(*b*)
12	Magnesium phosphate	150 lb./acre	(*c*)
13	(Unfertilized control)	—	—

The full dose in the instance of each of the treatments 1-12 contained 30 lb. P_2O_5/acre.

Plots measured 29 ft. by 10 ft. exclusive of ridges. A one-ft. border was discarded at harvesting ; the nett harvested area was 1/200 acre.

The purelines, *Pachchaiperumal* 2462/11 and *Vellai Illankalayan* 28061 were grown in *yala* and *maha* respectively ; their germination-flowering intervals approximated 69 and 96 days respectively. Two-weeks and three-weeks seedlings were transplanted in the instance of *Pachchaiperumal* 2462/11 and *Vellai Illankalayan* 28061 respectively. In both instances, there were two seedlings per hill, and hills were spaced six inches apart. Weeding was unnecessary and was not done.

The Tissamaharama Series.—The following 13 treatments were distributed over four randomized blocks :

Treatment No.	*Form of Phosphate*	*Rate of Application*	*Mode of Application*
1	Superphosphate	111 lb./acre (20 lb. P_2O_5)	(*a*)
2	Superphosphate	111 lb./acre (20 lb. P_2O_5)	(*b*)
3	Superphosphate	111 lb./acre (20 lb. P_2O_5)	(*c*)
4	Superphosphate	222 lb./acre (40 lb. P_2O_5)	(*a*)
5	Superphosphate	222 lb./acre (40 lb. P_2O_5)	(*b*)
6	Superphosphate	222 lb./acre (40 lb. P_2O_5)	(*c*)
7	Ammophos	100 lb./acre (20 lb. P_2O_5, 16·5 lb. N)	(*a*)
8	Ammophos	100 lb./acre (20 lb. P_2O_5, 16·5 lb. N)	(*b*)
9	Ammophos	100 lb./acre (20 lb. P_2O_5, 16·5 lb. N)	(*c*)
10	Ammophos	200 lb./acre (40 lb. P_2O_5, 33 lb. N)	(*a*)
11	Ammophos	200 lb./acre (40 lb. P_2O_5, 33 lb. N)	(*b*)
12	Ammophos	200 lb./acre (40 lb. P_2O_5, 33 lb. N)	(*c*)
13	(Unfertilized control)	—	—

The internal plot size exclusive of ridges was 52 ft. by 10 ft. The discard of a one-ft. border gave a nett harvested area of 1/109 acre.

The pureline *Vellai Illankalayan* 28061 was grown in both *yala* and *maha*. Three weeks seedlings were transplanted two per hill ; hills were spaced six inches apart. No weeding was necessary.

Results and Discussion

The variance analyses of grain yields in the Batalagoda series in the seasons in which treatment effects assumed significance are given in Table II. Yield data for six seasons are summarized in Table III. Phosphate applications produced significant responses in *maha* 1950/51, *yala* 1951, *yala* 1952 and *maha* 1952/53. The yield increases attributable to 30 lb. P_2O_5/acre were 328 lb./acre (15%) in *maha* 1950/51, 655 lb./acre (34%) in *yala* 1951, 484 lb./acre (30%) in *yala* 1952 and 669 lb./acre (43%) in *maha* 1952/53. No significant differences between forms of phosphate appeared in any season. In all seasons, however, both superphosphate and magnesium phosphate gave a higher average yield than saphos. Nevertheless, as this superiority did not reach significance in any season, saphos should be preferred on grounds of cost.

Table II—Analysis of Variance of Grain Yields at Batalagoda

	Degrees of Freedom	Sums of Squares				Mean Squares				Variance Ratios			
		Maha 1950/51	*Yala 1951*	*Yala 1952*	*Maha 1952/53*	*Maha 1951/52*	*Yala 1951*	*Yala 1952*	*Maha 1952/53*	*Maha 1950/51*	*Yala 1951*	*Yala 1952*	*Maha 1952/53*
Treatments	12	32·34	81·66	45·95	48·97	2·70	6·80	3·83	4·08	2·11*	5·57‡	2·12*	5·98‡
Kinds of Phosphate	3	10·29	6·44	8·90	2·37	3·43	2·15	2·97	0·79	2·69	1·76	1·64	1·16
Methods of application	2	3·86	16·85	11·43	2·11	1·93	8·42	5·71	1·05	1·51	6·90†	3·17	1·55
Interactions :													
Kind x Method	6	7·67	18·61	3·92	3·14	1·28	3·10	0·65	0·52	1·00	2·54*	0·36	0·77
Phosphate vs. None	1	10·51	39·76	21·71	41·36	10·51	39·76	21·71	41·36	8·24†	38·16‡	12·03†	60·62‡
Blocks	3	20·13	21·99	93·19	49·63	6·71	7·33	31·06	16·54				
Error	36	45·94	43·64	64·95	24·56	1·28	1·21	1·80	0·68				
Total	51	98·40	147·29	204·08	123·17								

* Significant at 5 per cent. point. † Significant at 1 per cent. point. ‡ Significant at 0·1 per cent. point.

Table III—Grain Yields at Batalagoda

Kind of Phosphate	Mode of Application		Yala 1950		Maha 1950/51		Yala 1951		Maha 1951/52		Yala 1952		Maha 1952/53	
	Yala	*Maha*	*Lb. per acre*	*% of Control*	*Lb. per acre*	*% of Control*	*Lb. per acre*	*% of Control*	*Lb. per acre*	*% of Control*	*Lb. per acre*	*% of Control*	*Lb. per acre*	*% of Control*
Hyperphosphate	Half dose	Half dose	2,114	115	2,548	115	2,433	128	2,801	116	2,056	128	2,231	142
	Full dose	—	1,914	102	2,489	112	2,498	131	2,767	115	2,098	131	2,091	134
	—	Full dose	2,004	107	2,805	127	2,573	135	2,864	119	1,932	120	2,371	151
Saphos	Half dose	Half dose	1,933	103	2,382	108	2,658	140	2,723	113	2,155	134	2,095	134
	Full dose	—	1,923	103	2,329	105	2,438	128	2,770	115	2,032	127	2,215	141
	—	Full dose	1,948	104	2,483	112	2,318	122	2,683	111	1,824	114	2,208	141
Superphosphate	Half dose	Half dose	2,268	121	2,504	113	2,653	139	2,888	120	2,174	135	2,304	147
	Full dose	—	2,383	127	2,516	114	2,728	143	2,679	111	2,142	133	2,271	145
	—	Full dose	2,288	118	2,545	115	2,379	125	2,932	121	2,010	125	2,318	148
Magnesium Phosphate	Half dose	Half dose	2,373	127	2.804	127	2,828	148	2,864	119	2,206	137	2,249	144
	Full dose	—	2,089	126	2,523	114	2,867	151	2,838	118	2,416	150	2,200	140
	—	Full dose	2,018	108	2,566	116	2,279	120	2,809	116	2,051	128	2,276	145
Unfertilized Control			1,868	100	2,205	100	1,899	100	2,416	100	1,607	100	1,567	100
Standard Error			—	—	±113	±5	±110	±6	—	—	±134	±8	±82	±5

For purposes of the present discussion, a cumulative effect is defined as the sum of a direct effect and a first-year residual. In the Batalagoda series, the method of phosphate application and its interaction with form of phosphate reached significance in *yala* 1951. The cumulative effects of the half dose (method (*a*)) and the direct effects of the full dose (method (*b*)) significantly exceeded the residual effects of the full dose in the instance of superphosphate and magnesium phosphate. Residual effects of hyperphosphate (method (*c*)) slightly exceeded its direct and cumulative effects. In the instance of saphos the cumulative effects of the half dose (method (*a*)) were the most marked. Over the whole series of experiments, however, application methods did not give consistent results with any of the phosphates.

The yield trends in successive *yala* and *maha* seasons in the Batalagoda series illustrated in Fig. I reveal no indication of appreciable second-year and later residuals.

The first season of fertilizer application in the Tissamaharama series has particular interest as it provided information relating to four levels of P_2O_5, viz., 0 lb. (treatments 3, 6, 9, 12 and 13), 10 lb. (treatments 1 and 7), 20 lb. (treatments 2, 4, 8 and 10) and 40 lb. (treatments 5 and 11) P_2O_5 per acre. The variance analysis of grain yields in this season is given in Table IV. Summaries of yield data for all five experimental seasons are presented in Table VI. The response to phosphate on the first season reached significance at the 0.1 per cent. point. Superphosphate was not significantly inferior to ammophos. Phosphate levels assumed significance at the 5 per cent. point; 40 lb. P_2O_5/ acre was significantly better than 10 lb. P_2O_5/ acre, but the intermediate level does not differ significantly from either. The response curves for super-

Table IV—Analysis of Variance of Grain Yields at Tissamaharama in the First Season—Yala 1949

		Sums of Squares	*Mean Square*	*Variance Ratio*
Treatments :				
Kinds of phosphate	1	0·40	0·40	0·10
Levels of phosphate	2	29·69	14·84	3·97*
Interaction :				
Kinds by Levels	2	6·91	3·45	0·92
Phosphate vs. None	1	94·59	94·59	25·29‡
Blocks	3	228·00		
Error	42	157·17	3·74	—
Total	51	516·76		

* Significant at 5 per cent. point.

‡ Significant at 0·1 per cent. point.

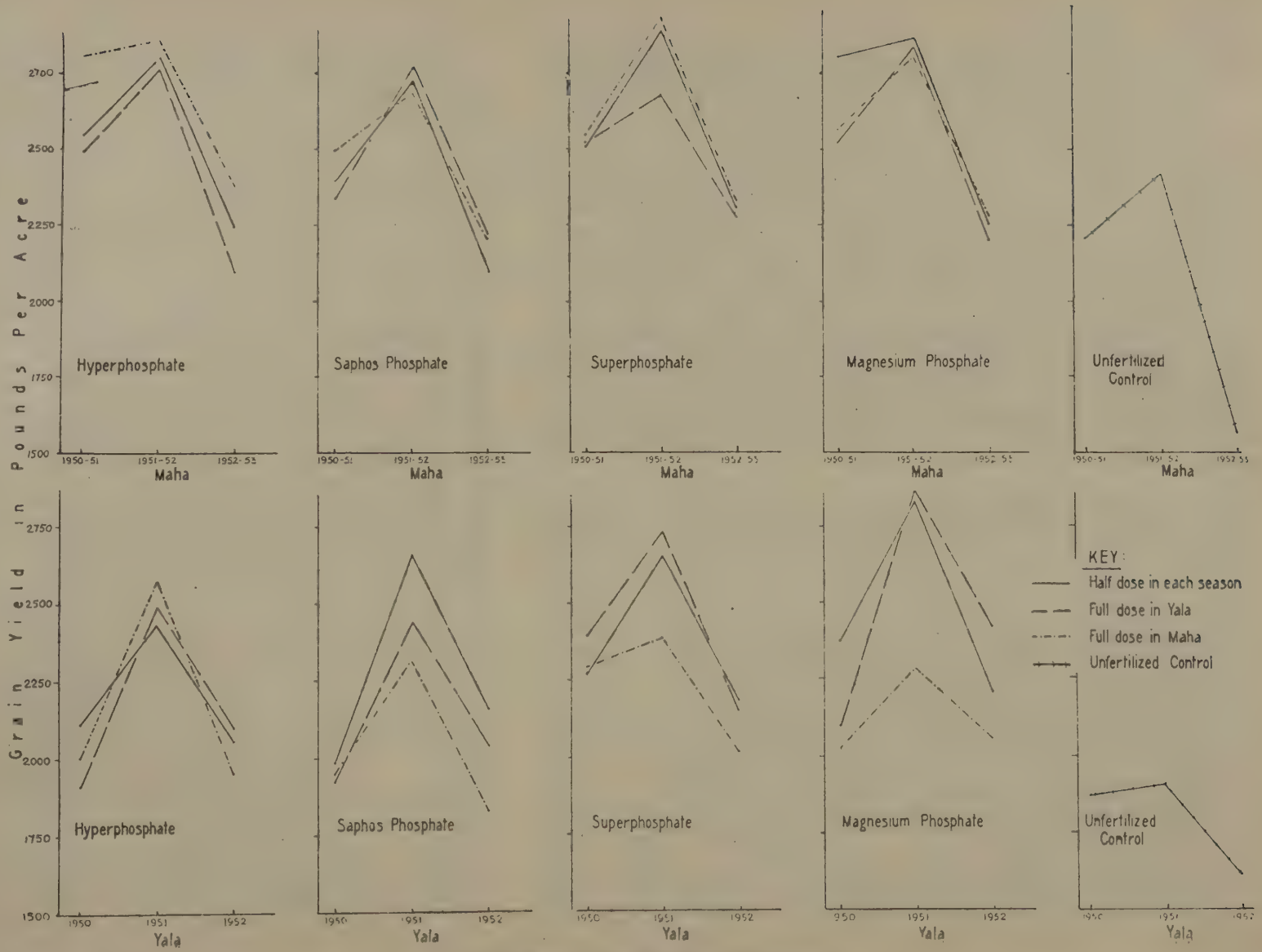


FIG. I—Response to various phosphates at Batalagoda.

Table V— Analysis of Variance of Grain Yields at Tissamaharama in Four Seasons Subsequent to the First

	Degrees of Freedom	Sums of Squares				Mean Squares				Variance Ratio			
		Maha 1949–50	*Yala 1950*	*Maha 1950–51*	*Yala 1951*	*Maha 1949–50*	*Yala 1950*	*Maha 1950–51*	*Yala 1951*	*Maha 1949–50*	*Yala 1950*	*Maha 1950–51*	*Yala 1951*
Treatments :	12	72·30	192·43	192·21	65·84	7·19	16·04	16·02	5·49	2·25*	3·06†	6·56‡	2·50*
Kinds of Phosphate	1	3·09	66·69	26·31	18·31	3·09	66·69	26·31	18·31	0·86	12·70‡	10·78†	7·04*
Levels of Phosphate	1	0·12	0·98	3·59	0	0·12	0·98	3·58	0	0·03	0·19	1·47	—
Methods of application	2	28·32	18·21	57·35	11·11	14·16	9·11	28·67	5·56	3·96*	1·74	11·75‡	2·14
Interactions—													
Kinds × Levels	1	5·47	10·55	12·57	12·23	5·47	10·55	12·57	12·23	1·53	2·01	5·15*	4·70*
Kinds × Methods	2	10·32	14·75	31·54	0·04	5·16	7·38	15·77	0·02	1·44	1·41	6·46†	—
Levels × Methods	2	10·10	25·71	21·07	5·66	5·05	12·86	10·53	2·83	1·41	2·45	4·31*	1·09
Kinds × Levels × Methods	2	1·06	11·60	5·19	1·08	0·53	5·80	2·59	0·54	0·15	1·10	1·06	0·21
Phosphate vs. None	1	13·91	43·94	34·58	17·39	13·91	43·94	34·58	17·39	3·89	8·37†	14·17‡	6·69*
Blocks	3	99·10	29·10	52·93	80·89	33·03	9·70	17·64	26·96	—	—	—	—
Error	36	128·84	188·93	87·72	93·59	3·58	5·25	2·44	2·60	—	—	—	—
Total	51	300·33	410·46	332·85	240·30								

* Significant at 5 per cent. † Significant at 1 per cent. ‡ Significant at 0·1 per cent.

Table VI—Grain Yields at Tissamaharama

Kind of Phosphate	Levels	Mode of Application	Yala 1949		Maha 1949/50		Yala 1950		Maha 1950/51		Yala 1951	
			Lb. per acre	% of Control	Lb. per acre	% of Control	Lb. per acre	% of Control	Lb. per acre	% of Control	Lb. per acre	% of Contro
Superphosphate	20 lb. P_2O_5/acre	Half dose in each season	3,277	112	2,567	107	1,876	122	3,606	109	3,488	106
	20 lb. do.	Full dose in *yala*	3,490	119	2,684	112	1,829	119	3,591	108	3,580	108
	20 lb. do.	Full dose in *maha*	3,121	106	2,622	109	1,767	115	3,572	108	3,513	106
	40 lb. do.	Half dose in each season	3,371	115	2,455	102	1,702	110	3,448	104	3,377	102
	40 lb. do.	Full dose in *maha*	2,998	102	2,701	113	1,793	116	3,666	111	3,350	101
Ammophos	20 lb. do.	Half dose in each season	3,220	110	2,586	108	2,141	139	3,536	110	3,523	107
	20 lb. do.	Full dose in *yala*	3,337	114	2,512	105	1,995	129	3,513	106	3,555	108
	20 lb. do.	Full dose in *maha*	3,342	114	2,720	113	1,801	116	3,770	114	3,578	108
	40 lb. do.	Half dose in each season	3,479	119	2,686	112	1,934	125	3,796	115	3,625	110
	40 lb. do.	Full dose in *yala*	3,642	124	2,461	103	2,416	157	3,442	104	3,796	115
	40 lb. d	Full dose in *maha*	3,137	107	2,859	119	1,986	129	4,193	127	3,557	108
Unfertilized Control	..	..	2,931	100	2,398	100	1,541	100	3,311	100	3,302	100
Standard error	..	..	±105	±3·6	±103	±4·3	±125	±8·1	±85	±2·6	±88	± 2·7

phosphate and ammophos are given in Fig. II. Up to the 20 lb. P_2O_5 /acre level, an application 10 lb. P_2O_5 /acre produced yield increases of 150 to 170 lb./acre and 115 to 190 lb./acre with superphosphate and ammophos respectively. With superphosphate beyond the 20 lb./acre level the response rate declines in the manner usual to a Mitcherlich curve. With ammophos on the other hand the curve continues to rise up to the 40 lb./acre point. Two factors may have cumulated into this differential response, viz., a nitrogen effect and a nitrogen-phosphate interaction.

The variance analyses for all subsequent seasons are given in Table V. Except in *maha* 1949/50, when the phosphate effect barely escaped significance, marked and significant phosphate effects have been noted in all seasons. In all the seasons except the first two, viz., *yala* 1949 and *maha* 1949/50, ammophos proved significantly superior to superphosphate. As indicated above, both a nitrogen effect and a nitrogen-phosphate interaction could have contributed to the superiority of ammophos. There is reason to believe that in the Tissamaharama series, nitrogen became a limiting factor in the later seasons.

The only seasons in which methods of fertilizer application became significant were *maha* 1949/50 and *maha* 1950/51. The results of the *maha* 1949/50 season call for comment. The comparison of phosphate vs. none narrowly missed significance. That the failure to achieve significance was due to the inclusion under the phosphate treatment, of several ineffective residuals

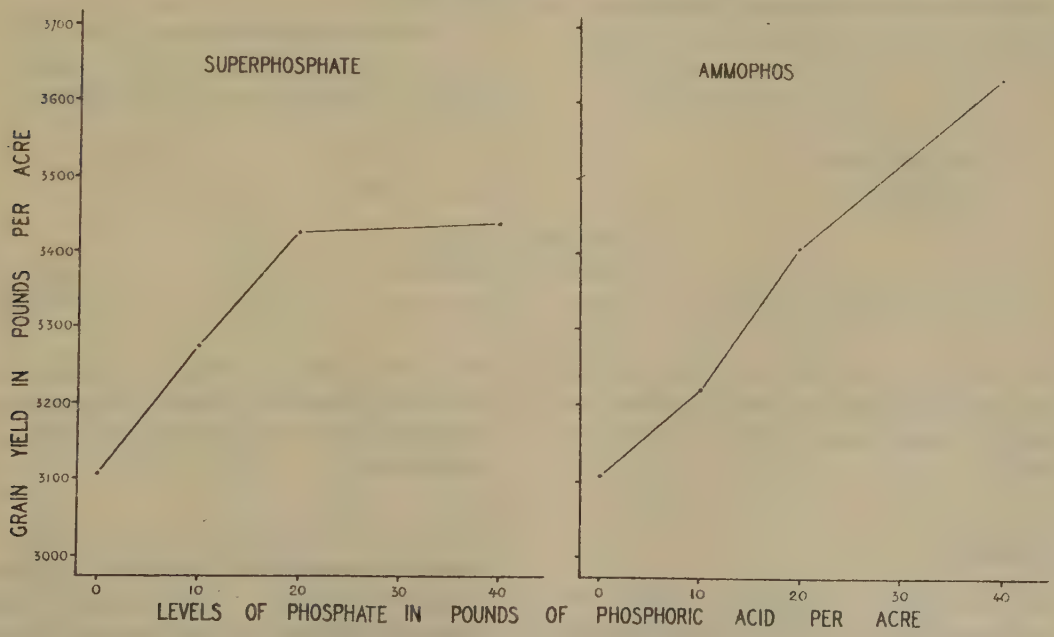


FIG. II—Response to various levels of superphosphate and ammophos in the first season of application at Tissamaharama.

and cumulative effects is evident from the significance of the methods mean square. The direct effects were superior to the residuals and cumulative effects. In *maha* 1950/51, the direct effects of ammophos significantly exceeded (*a*) the residuals at both levels of P_2O_5 (*b*) the cumulative effects at the 40 lb. P_2O_5 /acre level. In *maha* 1950/51, all first-order interactions assumed significance as well. (Tables VII and VIII.)

Table VII—Interaction of Kind of Phosphate and Level of Phosphate with Method of Application in Maha, 1950/51 : Grain Yields in lb./acre

Mode of Application	*Kind of Phosphate*		*Level of Phosphate*	
	Superphosphate	*Ammophos*	*20 lb. P_2O_5/acre*	*40 lb. P_2O_5/acre*
Half dose in each season	3526	3715	3620	3622
Full dose in *yala*	3544	3477	3551	3470
Full dose in *maha*	3618	3981	3671	3928

Standard Error = ±60
Significant difference = 173

Table VIII—Interaction of Kind of Phosphate with Level of Phosphate in Maha, 1950/51: Grain Yields in lb./acre

	Level of Phosphate	
	20 lb. P_2O_5/acre	*40 lb. P_2O_5/acre*
Superphosphate	3592	3540
Ammophos	3641	3813

Standard Error = ±49
Significant difference = 141

In none of the seasons subsequent to the first, did the variance analysis reveal a significant effect of fertilizer levels.

Summary

Two series of experiments designed to investigate the direct, residual and cumulative effects of phosphate forms and levels were conducted at the Central Rice Research Station, Batalagoda, and at the Rice Research Station, Tissamaharama.

In the Batalagoda series, the application of phosphate produced striking increases in grain yield ; the increases were significant in the second, third, fifth and sixth seasons. In no season,

however, did the various forms of phosphate, viz., superphosphate, saphos, hyperphosphate and magnesium phosphate, differ significantly in performance.

The method of fertilizer application and its interaction with form of phosphate assumed significance only in one season. In that instance, the direct and cumulative effects of superphosphate and magnesium phosphate significantly exceeded the residuals. Residuals in hyperphosphate slightly exceeded direct and cumulative effects.

In the Tissamaharama series, the phosphate response was consistent and marked in all seasons, and ammophos was superior to superphosphate in the last three seasons. Difference between fertilizer levels were significant only the first season : 40 lb. P_2O_5/acre was significantly superior to 10 lb. P_2O_5/acre.

In the two seasons at Tissamaharama that application methods assumed significance, direct effects significantly exceeded cumulative effects and residuals.

Acknowledgment

The assistance of Messrs. K. J. Gunawardena, J. Sithamparanathan, I. P. S. Dias and H. Weeraratne, in the execution of the trials and the recording of data is gratefully acknowledged. We are also indebted to officers in the Chemistry Division for valuable advice and assistance.

References

HAIGH, J. C. and JOACHIM, A. W. R. 1933—Studies on paddy cultivation. I. The paddy crop in relation to manurial treatment—A general discussion.—*Trop. Agricst. 81*, 3–10.

HAIGH, J. C. and JOACHIM, A. W. R. 1935—Studies on paddy cultivation V. (A) The effect of time of application of fertilizer. (B) The effect of the form of phosphoric acid applied.—*Trop. Agricst. 85*, 269–277.

IGNATIEFF, V. 1951—Results of experiments and practical experience in the use of fertilizers, manures and soil amendments with rice.

Paper No. IRC/FP/51/2 of the Working Party on Fertilizers of the International Rice Commission, Bogor.

Manurial Experiment with Potato at Rahangala

S. KANDIAH and D. M. RODRIGO

THE cultivation of the potato (*Solanum tuberosum*) has been confined to a restricted area in the Nuwara Eliya district and the Udukinde area of Uva. It has not spread beyond this zone mainly because the climatic conditions are not suitable. Even the local species (*Solanum commersonii*) has not proved successful elsewhere. One of the serious factors affecting the cultivation of the crop even in the area referred to here is disease. It is hoped that with the introduction of disease free material of improved varieties from abroad and the possibilities of controlling the disease that affect the crop, cultivation will be more remunerative and intensive.

Of all cultivated crops, potato is considered to respond most to manuring, but no information on the fertilizer requirements of potato under Ceylon conditions has been available. It was, therefore, considered desirable to lay down a manurial trial at Rahangala, the chief potato growing area in Ceylon, on a virgin patana soil, with a view to assessing its manurial requirements under the conditions obtaining at this centre.

Rahangala in Welimada is below 4,500 feet in elevation and the land is of the dry patana type subject to long periods of drought. The soils are generally shallow in depth and the surface layer is a well drained reddish brown heavy loam, acid in reaction and low in bases and in available phosphoric acid. Unlike the wet patana soils at higher elevations, these soils are low in organic matter and consequently in nitrogen.

Experimental Design

The effect of nitrogen, phosphoric acid, potash and cattle manure, each at three levels was studied. Nitrogen was supplied as sulphate of ammonia at 0, 2, 4 cwt. per acre, phosphoric acid as saphos phosphate at 0, 2, 4 cwt. and potash as sulphate of potash at 0, 1, 2 cwt. per acre. The rates for cattle manure were 0, 6, and 12 tons. The variety of potato grown was Great Scott. A 3^4 factorial unreplicated design consisting of 81 treatment combinations distributed in 9 blocks of 9 plots each was used and the treatments were confounded and randomized. Each block was 90′ × 50′ and each plot 8′ × 50′. The spacing was 2′ between furrows and 1′ within furrows. At harvest, a single border row of plants on the four sides of each plot was discarded and the weights of the healthy and rotten tubers were recorded separately. Control measures for pests and diseases recommended by the Entomologist and the Plant Pathologist were adopted regularly and uniformly for all plots. Cattle manure was applied on February 26, 1953, the fertilizers on March 4, 1953, and planting was completed on the following day. The crop was harvested between June 27 and July 1, 1953.

Results and Discussion

In Table I are given the yields of tubers for the 81 plots and in Table II the weights of healthy and rotten potatoes for each of the treatments and also the percentage of rotten ones expressed on the whole crop. For easy computation, the yields are also shown as cwt. per acre. In Fig. I, the responses to increasing levels of nitrogen, phosphoric acid, potash and organic manure (cattle manure) are graphically shown. The results have been statistically examined and the analysis of variance is shown in Table III. The results would show (1) a progressive increase

Table I—Plot Yields in Ounces

		N_0			N_1			N_2		
		K_0	K_1	K_2	K_0	K_1	K_2	K_0	K_1	K_2
P_0	M_0	0	32	24	58	12	15	521	184	272
	M_1	836	570	352	510	127	836	933	1128	628
	M_2	776	586	340	588	1482	228	1006	1142	292
P_1	M_0	185	264	230	264	518	282	209	118	488
	M_1	484	200	490	982	883	1126	1042	1280	1094
	M_2	820	600	890	615	1052	685	1620	1256	929
P_2	M_0	174	300	508	434	334	57	362	333	488
	M_1	458	502	123	1222	1412	924	896	1196	804
	M_2	424	98	480	944	1292	906	1412	1180	1444

Table II—Weights of Healthy and Rotten Tubers

	Yield in ounces (good)	*Cwt. per acre*	*Wt. of rotten potatoes in ounces*	*Wt. of rotten potatoes in cwt. per acre*	*Rotten/yield per cent.*
N_0	10746	24·19	1114	2·51	9·39
N_1	17788	40·04	1618	3·64	8·34
N_2	22257	50·09	2388	5·37	9·69
P_0	13478	30·33	1726	3·88	11·35
P_1	18606	41·88	1734	3·90	8·53
P_2	18707	42·10	1660	3·74	8·15
K_0	17775	40·01	1751	3·94	8·97
K_1	18081	40·69	1837	4·13	9·22
K_2	14935	33·61	1532	3·45	9·25
M_0	6666	15·00	403	·91	5·70
M_1	21038	47·35	2159	4·86	9·31
M_2	23087	51·96	2558	5·76	9·97
Sig. diff.	2770	6·23			

in yield up to 4 cwt. per acre of sulphate of ammonia, the maximum quantity used. (2) Saphos at 2 cwt. per acre has given appreciable increase in yield over the control, but the 4 cwt. per acre has not significantly proved better than the 2 cwt. application. Another important factor is that saphos could very well replace the much costlier super, that is generally used for manuring potato on these soils. (3) Potash at 1 cwt. per acre has hardly shown any increase over the control and at 2 cwt. it had definitely depressed yields. (4) Cattle manure behaves like nitrogen in increasing yields with increasing dosage up to 12 tons per acre, the maximum quantity used.

As regards the incidence of rot, it would be seen from Table II that neither nitrogen nor potash appears to produce any marked effect. While phosphoric acid in increasing doses tends to reduce the incidence, organic matter on the other hand appears to increase it. The high significance of the experiment as shown by the analysis of variance would indicate that the incidence of rot does not invalidate the experiment.

In Tables IV-IX are shown the interactions of one fertilizer against another and in Figs. II-VII these are graphically represented.

Table III—Analysis of Variance

	Degrees of freedom	*Sums of squares*	*Mean square*	*Variance ratio*	*F Value for Significance*		
					5%	*1%*	*0·1%*
Nitrogen	2	2,494,628	1,247,314	35·84‡	3·23	5·18	8·25
Phos. acid	2	662,334	331 167	9·56‡	3·23	5·18	8·25
Potash	2	222,921	111,460	3·20	3·25	5·18	8·25
Organic manure	2	5,930,889	2,965,444	85·21‡	3·25	5·18	8·25
Interactions Nitrogen X Phos. acid	4	478,693	119,673	3·44*	2·61	3·83	5·70
Nitrogen X Potash	4	249,058	62,265	1·79	2·61	3·83	5·70
Nitrogen X Organic manure	4	697,187	174,297	5·01†	2·61	3·83	5·70
Phos. acid X Potash	4	202,818	50,705	1·46	2·61	3·83	5·70
Phos. acid X Organic manure	4	17,624	4,406	0·127	2·61	3·83	5·70
Potash X Organic manure	4	237,511	59,378	1·71	2·61	3·83	5·70
Blocks	8	1,959,390	244,924	7·04‡	2·18	2·99	4·21
Error	40	1,392,079	34,802				
Total	80	14,545,143					

* Significant at 5 per cent. † Significant at 1 per cent. ‡ Significant at 0.1 per cent.

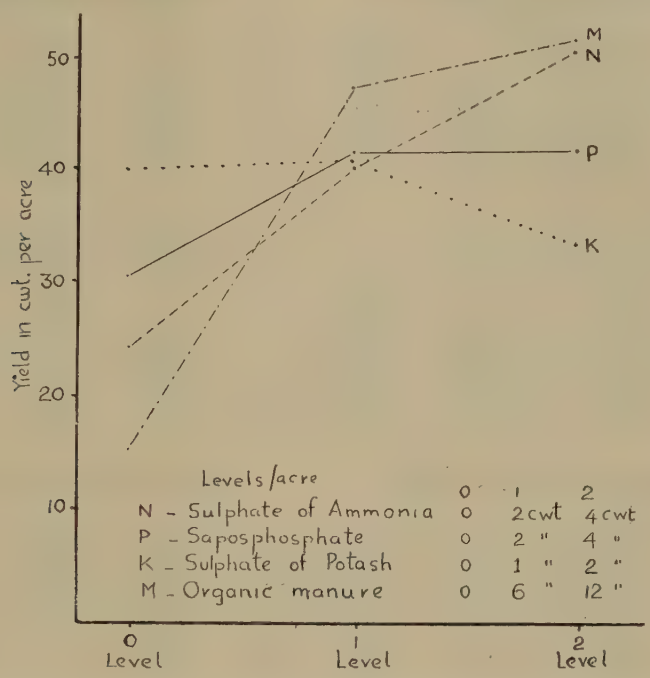


FIG. I—Response to increasing levels of Nitrogen, Phosphoric acid, Potash and Organic manure—(cattle manure).

Table IV and Fig. II refer to the responses to increasing levels of phosphoric acid at different levels of nitrogen. An examination of the results would indicate that (1) though phosphoric acid at the first level shows, in the absence of nitrogen, a slight increase in yield (please see *a* in Fig. II) the double dose does under these conditions not only fail to increase it, but actually depresses it (see *b*) below the level of no-phosphoric acid. With the application of nitrogen however, a tremendous increase in yield is obtained (see *c*.) (2) Phosphoric acid with corresponding increases in nitrogen tends to enhance yields, but the response to the double dose of phosphoric acid is not significantly superior to that of the single dose at the second level of nitrogen (see *d*). (3) In the absence of phosphoric acid the rate of increase in yields with increasing doses of nitrogen is high particularly at the second level (see *e*). In the absence of nitrogen however, the rate of increase with increasing doses of phosphoric acid is only small at the first level and depressing at the second level. It could therefore be seen that these soils respond well to nitrogen.

Table V and Fig. III deal with the responses to increasing levels of potash at different levels of nitrogen. Under the conditions of this trial the general tendency is for any application of potash to depress yields, be it in the presence or absence of any additional nitrogen (see *f*).

Table IV—Nitrogen-Phosphoric acid

	N_0	N_1	N_2	*Total*
P_0	3,516	3,856	6,106	13,478
P_1	4,163	6,407	8,036	18,606
P_2	3,067	7,525	8,115	18,707
Total	10,746	17,788	22,257	50,791

Table V—Nitrogen—Potash

	N_0	N_1	N_2	*Total*
K_0	4,157	5,617	8,001	17,775
K_1	3,152	7,112	7,817	18,081
K_2	3,437	5,059	6,439	14,935
Total	10,746	17,788	22,257	50,791

Table VI—Nitrogen—Organic manure

	N_0	N_1	N_2	*Total*
M_0	1,717	1,974	2,975	6,666
M_1	4,015	8,022	9,001	21,038
M_2	5,014	7,792	10,281	23,087
Total	10,746	17,788	22,257	50,791

Table VII—Phosphoric acid—Potash

	P_0	P_1	P_2	*Total*
K_0	5,228	6,221	6,326	17,775
K_1	5,263	6,171	6,647	18,081
K_2	2,987	6,214	5,734	14,935
Total	13,478	18,606	18,707	50,791

Table VIII—Phosphoric acid—Organic manure

	P_0	P_1	P_2	*Total*
M_0	1,118	2,558	2,990	6,666
M_1	5,920	7,581	7,537	21,038
M_2	6,440	8,467	8,180	23,087
Total	13,478	18,606	18,707	50,791

Table IX—Potash—Organic manure

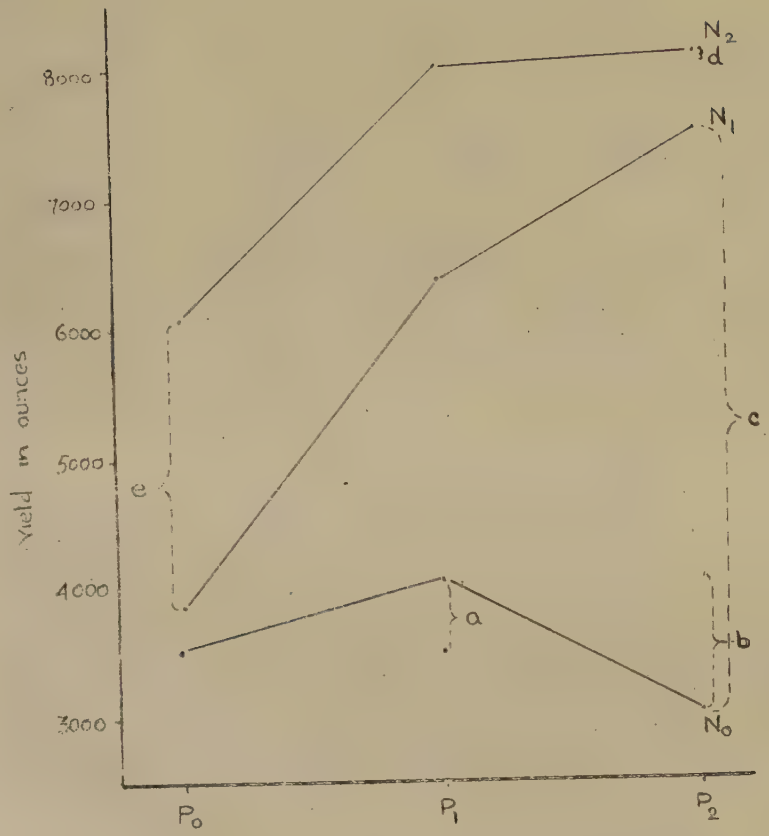
	K_0	K_1	K_2	*Total*
M_0	2,207	2,095	2,364	6,666
M_1	7,363	7,298	6,377	21,038
M_2	8,205	8,688	6,194	23,087
Total	17,775	18,081	14,935	50,791

Table VI and Fig. IV show the responses to increasing levels of organic manure at different levels of nitrogen. Nitrogen and organic manure seem to be complementary in their effect, as progressive increases in response could be observed with increasing quantities. It would however be noted that the percentage of increase in yield at the first level of organic manure is tremendously superior to that at the second level (compare *g* with *h*). But the rate of increase at each of the three levels of nitrogen is almost the same (see *j*). These results would stress the importance of the application of organic manure even in limited quantities to these soils.

Table VII and Fig. V indicate the responses to increasing levels of potash at different levels of phosphoric acid. The behaviour of potash under these conditions is more or less similar to that in the presence of nitrogen. While potash at the first level does not perform any better than no-potash, it definitely depresses the yields at the second level (see *t*). The second level of phosphoric acid either in combination with nitrogen or potash is not significantly superior to the first level (see *l*).

Table VIII and Fig. VI refer to responses to increasing levels of phosphoric acid at different levels of organic manure. The interaction between these two factors is least, as could be seen from the nature of the curves as well as from the analysis of variance. Here again the performance of phosphoric acid at the second level is not better than that at the first level (see *q*).

Table IX and Fig. VII show the responses to increasing levels of organic manure at different levels of potash.



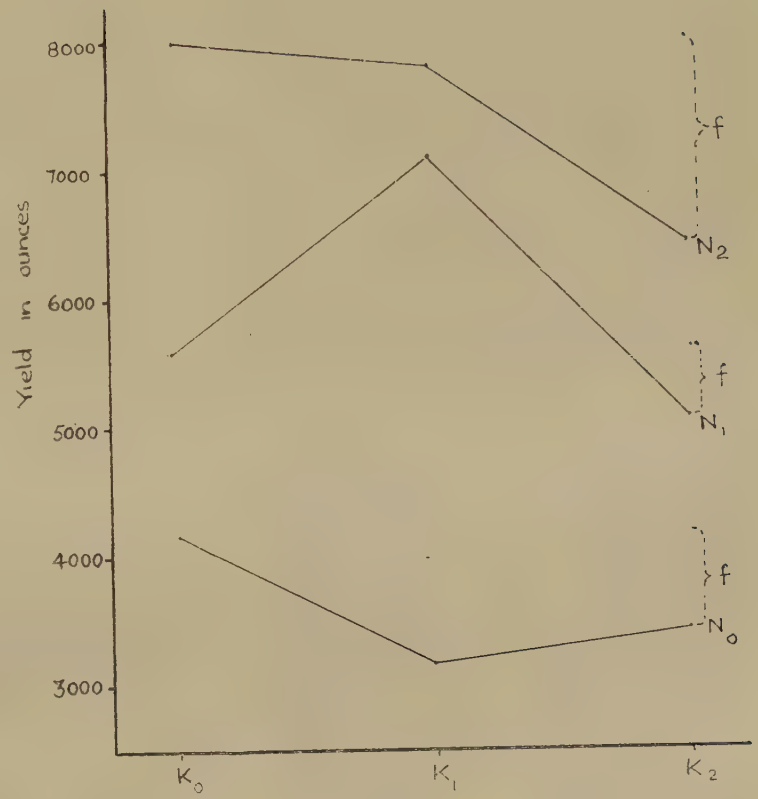


FIG. II—*Left:* Response to increasing levels of Phosphoric acid at different levels of Nitrogen.
FIG. III—*Right:* Response to increasing levels of Potash at different levels of Nitrogen.

The high increase due to the first level of organic manure (see *r*) and the depression brought about by the second level of potash (see *s*) are confirmed by the results shown here.

Nitrogen

Nitrogen has been found to give progressive increase in yields with increasing rates up to 4 cwt. per acre, the maximum quantity used. Russel and Garner (1) furnish figures to illustrate the importance of added nitrogen to potato. The yield of 3.37 tons with P & K only was raised to 6.72 tons with the addition of nitrogen. Similarly the yield of 5.6 tons with F.Y.M. and super was increased to 7.2 tons with nitrogen application. They however found that adequate supplies of P & K were necessary to obtain these increased yields. In this experiment, however, it will be noted, that nitrogen gives increased yields even without any addition of P or K and that this increase is greater, the larger the quantity of nitrogen applied. It will be seen, therefore, that

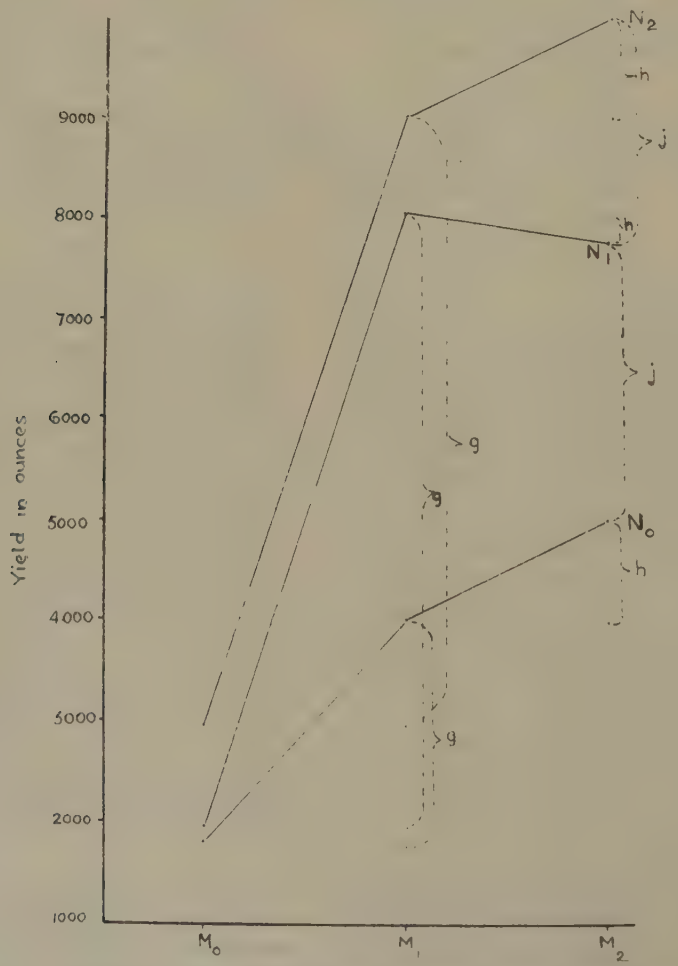


FIG. IV—Response to increasing levels of Organic manure at different levels of Nitrogen.

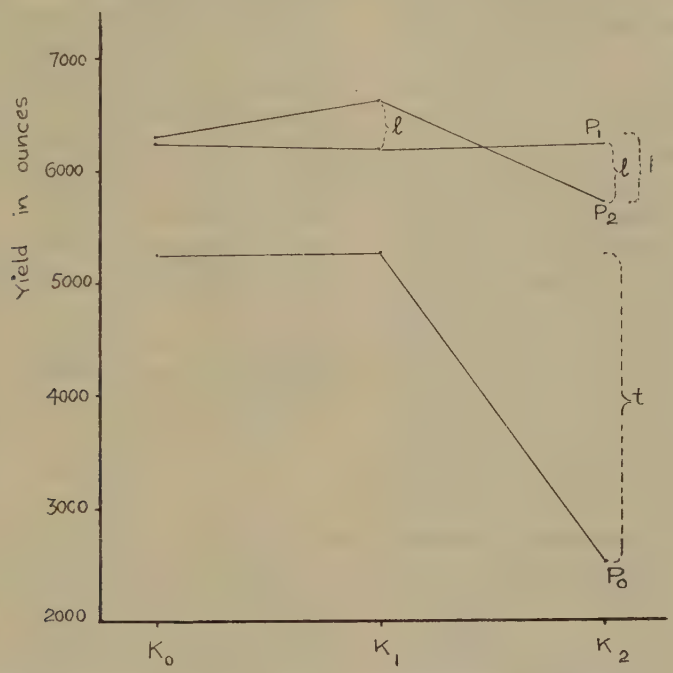
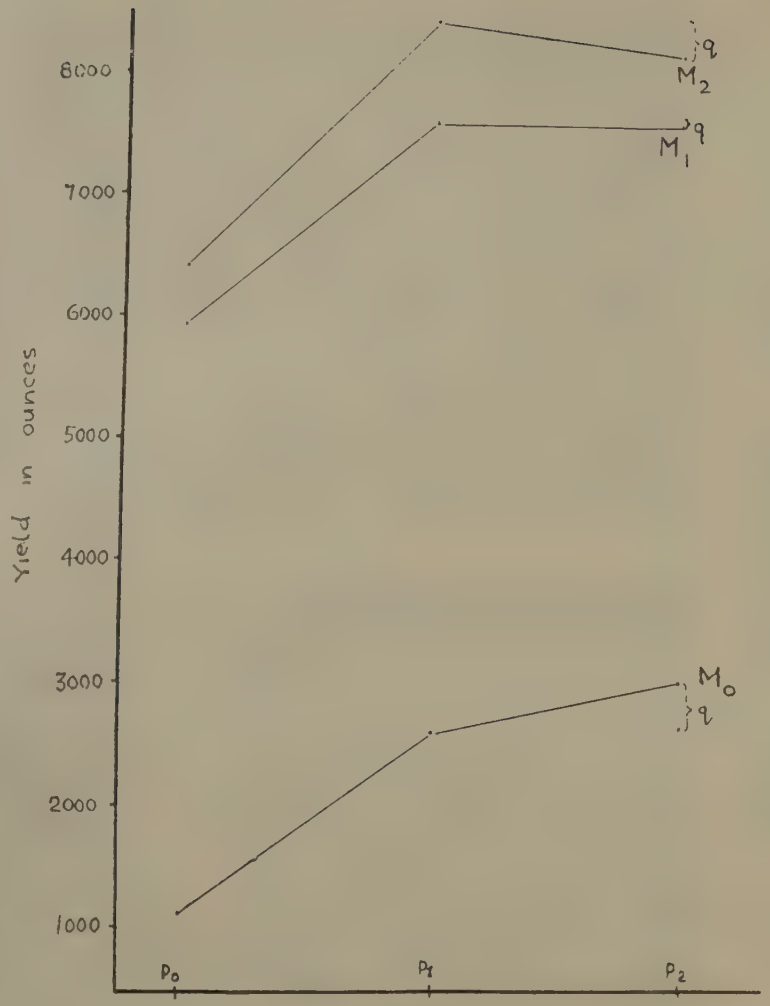


FIG. V—Response to increasing levels of Potash at different levels of Phosphoric acid.

nitrogen is the main limiting factor under our conditions, as tropical soils are very low in this constituent when compared with those of the temperate regions. Cowie (2) is of opinion that nitrogenous manuring is more essential for short-aged crops and more potash and phosphoric acid for long-aged ones. The introduced variety Great Scot used in this experiment is normally a five month crop in Europe, but it takes only three and a half months under our conditions. This may perhaps afford additional reason for the necessity for nitrogen.

Phosphoric acid

In accordance with the practice in Europe, super-phosphate has been used in the past for manuring potato in the Welimada area. As mentioned earlier these soils are lateritic in nature and acid in reaction and any phosphoric acid added in the form of super is likely to be fixed by the soil and made comparatively unavailable. Besides, phosphoric acid in super is nearly three times as costly as that in saphos. It was, therefore, decided to use only saphos in this trial. As expected, this fertilizer proved to be quite suitable for these soils and from the results furnished it will be clear that an application of 2 cwt. of saphos was quite sufficient to meet the full requirement of the crop. It will further be noted that the yield, due to the 4 cwt. application, did not in any combination prove significantly superior to that of the 2 cwt. application. Ellis (3) had also found local rock phosphate in Jamaica to be quite suitable for potatoes on the acid soils found there.



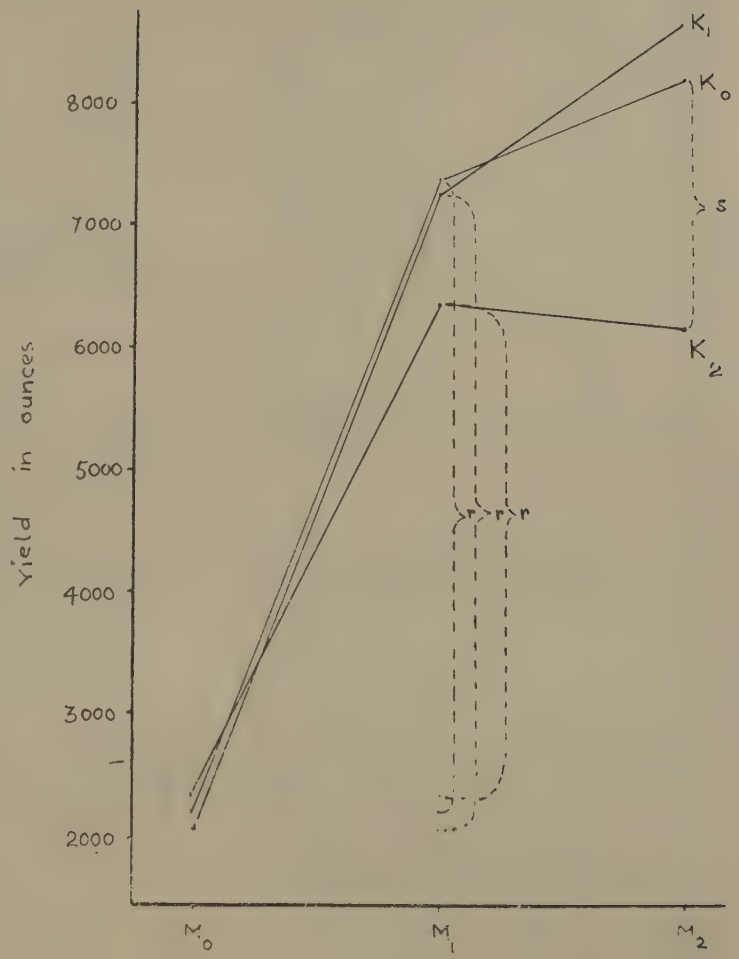


FIG. VI—*Left :* Response to increasing levels of Phosphoric acid at different levels of Organic manure.
FIG. VII—*Right :* Response to increasing levels of Organic manure at different levels of Potash.

Phosphates have been considered to be very necessary to potato and in fact in some places is the only fertilizer added. Wallace (4) indicates that recent work has shown that the amount applied can be greatly reduced from what was customarily employed. It is an established fact that phosphates hasten maturity and often prove useful for long-aged crops. As already pointed out, under our conditions, the variety becomes short-aged and this may perhaps account for the failure in the case of the heavier application to produce higher yields.

Potash

Two forms of potash fertilizers are commonly used; muriate of potash, where the potassium is in the form of chloride and sulphate of potash. Cowie (2) has demonstrated that chlorine is harmful to potato and that muriate of potash depresses the yield. Chlorides are also known to affect the cooking quality of potato. Sulphate of potash though more costly than muriate is preferred as a manure for potato and this form of potash was used in this trial. Potato is grown for its tuber and potash is considered the main requirement for any root crop. In any manure mixture for potato used in Western countries, great stress is laid on potash. In this trial, however, the addition of potash not only failed to give any increase in yield, but it actually depressed it in any combination, be it with high nitrogen, high phosphoric acid or high organic manure. Considering the fact that lateritic soils of Welimada are low in replaceable potassium, this situation is hard to understand. It should, however, be pointed out that soil analysis as a means of assessing the nutrient supply to crops is long discredited and much reliance therefore cannot be placed on it. Besides, De Turk *el al.* (5) have shown that the various forms of potash in the soil are in a reversible equilibrium and the replaceable potash is released from the total as plants make use of the former. Though these soils are low in replaceable bases, patana soils are fairly rich in total potash when compared with those in the low country wet zone (6). Albrecht (7) has established that while a general loss of bases takes place as a result of laterization, the loss of exchangeable calcium is far greater than that of potassium. It is, therefore, possible that the potash supplying power of these soils is greater than what it appears to be. The failure of response to potash may also be due to the upset in the nutrient balance caused by the application of potash. As already mentioned the calcium and magnesium status of this acid lateritic soil is low, but Russel (8) had pointed out the importance of calcium for potato nutrition and Smith & Mash (9) the necessity for magnesium. To a soil already deficient in these essential elements, the addition of potash might not have proved beneficial and the yield was adversely affected. The response to potash in the presence of adequate supply of calcium and magnesium should, therefore, be tested out.

Organic Manure

Organic manure has given the largest increase in crop yield, but a fact worthy of note is the very marked response to the initial dose of 6 tons per acre. The increase in yield for the additional application is not so high. This would show the extreme importance

of the application of organic manure to these soils, however limited it may be in quantity. It has already been pointed out that the incidence of rot increases with increasing quantities of organic manure. Russel & Garner (1) also found an increase in the amount of diseased tubers with the application of farmyard manure and these authors put it down to the luxuriance of the crop treated with this manure. In this experiment also, the crop growth was luxuriant and the largest increase in yield was obtained from this treatment.

Conclusion

Under the conditions obtaining in this experiment the best response has been shown by the application of 12 tons of cattle manure, 4 cwt. of sulphate of ammonia, 2 cwt. saphos and no potash. It may not be always possible to procure such a large quantity of cattle manure or compost as 12 tons, but stress had been laid on the application of even smaller quantities. Although 4 cwt. of sulphate of ammonia has been found to show the best response, it may not be advisable to apply such a large amount to a crop like potato, which is very susceptible to disease and pest attack, as an excess of nitrogen is known to predispose a crop to these attacks. A 3 cwt. application would appear to be the optimum under these conditions. The phosphates can be supplied as 2 cwt. of saphos phosphate. Although potash has not shown any response, considering the variability in soils it may not be advisable to drop it altogether and a moderate application of ½ cwt. per acre for the present is recommended.

Acknowledgment

Our thanks are due to Mr. L. H. Fernando, Acting Botanist & Senior A. R. O., for giving us the design of the experiment and to Mr. D. J. Soysa, D. A. O., Uva, and the staff at Rahangala for all their assistance in carrying out this trial.

References

1. Russel, Sir E. J. & Garner, H. V.—The Rothamsted experiments on the manuring of Potatoes. Part 1. Effects of nitrogenous, phosphatic and potassic manuring. *The Empire Journal of Experimental Agriculture* Vol. IX 1941. 195-215.

2. Cowie, G. A.—The relative responses of the potato crop to different potash fertilizers. *The Empire Journal of Experimental Agriculture* Vol. XI 23-32.

3. Ellis, T. O.—*Jamaica Department of Agriculture Bulletin* No. 40.

4. Wallace, J. C.—*Ministry of Agriculture and Fisheries. Bulletin* No. 94.

5. De Turk *et al.*—Potash Fixation in Corn Belt Soils. *Soil Science* Vol. LV. 1-2.

6. Ponnamperuma, F. M.—The potash status of Ceylon soils. *The Tropical Agriculturist* Vol. CVIII No. 2 1952. 94-101.

7. Albrecht, W. A.—Potassium in the Soil Colloid Complex and Plant Nutrition. *Soil Science* Vol. LV 1943. 13-21.

8. Russel, Sir E. John.—*Soil Conditions and Plant Growth, 8th Edition* 474.

9. Smith, O. & Mash, L. B.—Effect of certain minor elements on chemical composition and cooking quality of potato tubers. *Proceedings of the American Society of Horticultural Science* Vol. 35. 530-533.

Fungicidal Control of Late Blight of Potatoes at Rahangala

J. W. L. PEIRIS and P. J. DE ZILVA

THE potato crop is liable to a considerable number of diseases caused by fungi, bacteria and viruses and the successful cultivation of this crop depends on the occurrence of these in the locality and the extent to which control measures for these diseases are economically practicable in the area. Of these diseases, late blight caused by the fungus *Phytophthora infestans* (Mont de Bary) is perhaps most commonly associated with this crop wherever it is grown. Fungicidal control of late blight has been the subject of study by numerous workers and in a great majority of cases the efficacy of spray treatments has been vindicated so that they have become a routine practice in the cultivation of this crop. The destructiveness of this disease varies from season to season and serious losses are still reported especially exacted from the unwary farmer who has neglected to spray his crop. Climate and rainfall are important factors in determining the extent of control obtained by spray treatments.

The first record of the cultivation of potatoes in Ceylon dates back to 1812 when Mr. J. F. Lorenz was stated to have successfully grown this crop on a small scale in Morawak Korale. (1). The local potato or Nuwara Eliya potato *Solanum commersonii* which originated in Uruguay was introduced to Hakgala Gardens in 1909 according to Macmillan (2) and 'yielded fair sized tubers closely resembling the common potato both in appearance and eating quality but the yield is poor as compared with the latter'. The statement that *Solanum commersonii* was found at the time to be resistant to disease has been borne out by the fact that it is still found in cultivation in the Nuwara Eliya district without even the elementary precautions of disease control under which conditions the other varieties have been badly affected.

Various attempts at growing potatoes were made recently at the higher elevations of the island at Bopatalawa, Ambewela and Mahagastota where late blight was observed to be one of the most important factors in reducing yields owing to the rather high precipitation and mist obtaining in these areas. With the beginning of the cultivation of this crop at Rahangala and its surroundings it was thought more feasible to explore the possibilities of the fungicidal control of late blight owing to the drier climate here when compared with the earlier mentioned places. Moreover, the assessment of the effects due to other diseases could not be made until the overall effects of late blight were eliminated or reduced. The following experiment was therefore designed to find out whether late blight could be economically controlled under the conditions at Rahangala and to what extent it decreased the yield and brought about a reduction in tuber size.

Experimentation

The experiment was laid out at Rahangala Experiment Station. The layout took the form of five randomized blocks each of seven plots. Each plot which was 1/272 of an acre in size consisted of twelve rows of plants with eight plants per row making a total of 96 plants per plot. Records were taken from a central area carrying 60 plants (10 rows of 6 plants) leaving a row all round to overcome border effects. As the crop was grown under irrigation, bunds were so arranged as to enable irrigation of each plot separately to eliminate the possibility of water from one plot passing on to another.

The experimental plots were manured uniformly with cattle manure at the rate of 5 cwt. per acre and with a dressing of artificial fertilizers at 7 cwt. per acre, consisting of 3 cwt. of sulphate of ammonia, 2 cwt. of sulphate of potash and 2 cwt. of superphosphate (conc.). Planting was of the ridge and furrow system with 1 foot wide ridges alternating with 1 foot wide furrows. The cattle manure and the artificials were placed in the furrow and mixed well with the soil. Seed consisted of certified tubers of the variety Great Scott, tubers being so selected that each approximately weighed 1 1/3 oz. Tubers were planted in the furrow at a spacing of 10 inches between plants and 2 feet between rows and covered over with 2-3 inches of soil.

Fungicidal Treatments

Three fungicidal sprays were used :

(*a*) A proprietary cuprous oxide spray containing 50 per cent. of copper (Perenox) at the rate of 4 oz. in 10 gallons.

(*b*) A proprietary copper oxychloride spray containing 50 per cent. copper (Cupravit) at the rate of 4 oz. in 10 gallons.

(*c*) Bordeaux mixture—prepared according to the 4-4-40 formula.

To each spray mixture was added an emulsified white oil Albolineum. 2 at the rate of 1.6 oz. in 10 gallons as a spreader.

These three fungicides were used at two intervals of application, weekly and fortnightly and each block had an unsprayed control. The above treatments were randomized in each of the five blocks.

Spraying Technique

spraying was carried out with Knapsack sprayers. The spray lance was fitted with an angle bend to facilitate the spraying of the lower surfaces of the leaves thoroughly and the single nozzle delivered a fine mist of spray. The amount of fungicide necessary to spray each plot naturally increased with the increase in size of the plants. No attempt was made to economize on the spray but rather the object was to ensure the complete coverage of the plant. When the plants were fully grown approximately one gallon of spray was necessary for each plot of 96 plants (1/272 acre). As different fungicides were to be used on different plots in the same block, jute hessian screens were held round the plot sprayed to prevent spray drift from it to the neighbouring ones.

Maha Season, 1952, January-April

For this season the experiment was planted out on January 24, 1952. A

rather heavy shower (1.82 in.) followed on the evening of this day and it is possible that some of the effects of the artificials may have been lost. However, this effect would have been felt all over the experimental area. Sprouting occurred fairly uniformly although a few tubers were a little belated in their germination. A few vacancies due to seed piece decay were noticed. The number of vacancies was, however, small and scattered all over the plots so that they could not be considered to have materially altered the subsequent yield and other data.

The first spraying was carried out on February 27, 1952, when the plants were 10 inches in height, approximately one month from the date of planting. At this time there was no evidence of early or late blight on any of the plants in the plots. Thereafter the respective plots were sprayed weekly or fortnightly as the case may be until nine weekly sprayings had been given. Spraying operations were generally carried out early in the morning or late in the evening in order to avoid scorching of leaves. It is worthy of note that no spray scorch was observed in any of the plots.

It was observed that the Bordeaux mixture imparted a deeper bluish green colour to the plants. Cupravit caused a slight intensification of the natural green while the Perenox-sprayed plants were greenish brown owing to the colour of this fungicide. Bordeaux-sprayed plants were healthier and slightly larger than those sprayed with the proprietary fungicides.

Rainfall. A glance at the monthly rainfall chart Fig. I shows that the precipitation for the period of growth of this crop was much higher than the average for the same period at Rahangala for the last seven years. For April 1952, rainfall was more than double the average and as this period coincided with the latter part of the growth period of the crop, when it is most susceptible to late blight, it is evident that the treatments have had a very rigorous trial as regards the assessment of their efficacy in controlling the disease.

Results. Early blight began making its appearance in the fifth week after planting. The infection was light and not confined to any particular treatment or control. Table I shows the number of plants showing infection due to early blight on March 19, 1952. Any plant showing even one leaf spot was considered infected.

Table I—Average number of plants infected with Early and Late Blight on March 19, 1952

Treatments	*Per.nox*		*Cupravit*		*Bordeaux mixture*		*Unsprayed*
Weekly or fortnightly	W.	F.	W.	F.	W.	F.	
Early blight	5·2	4·4	6·8	6·6	5·6	5·0	5·8
Late blight	0	0	0	0	0	0	3·8

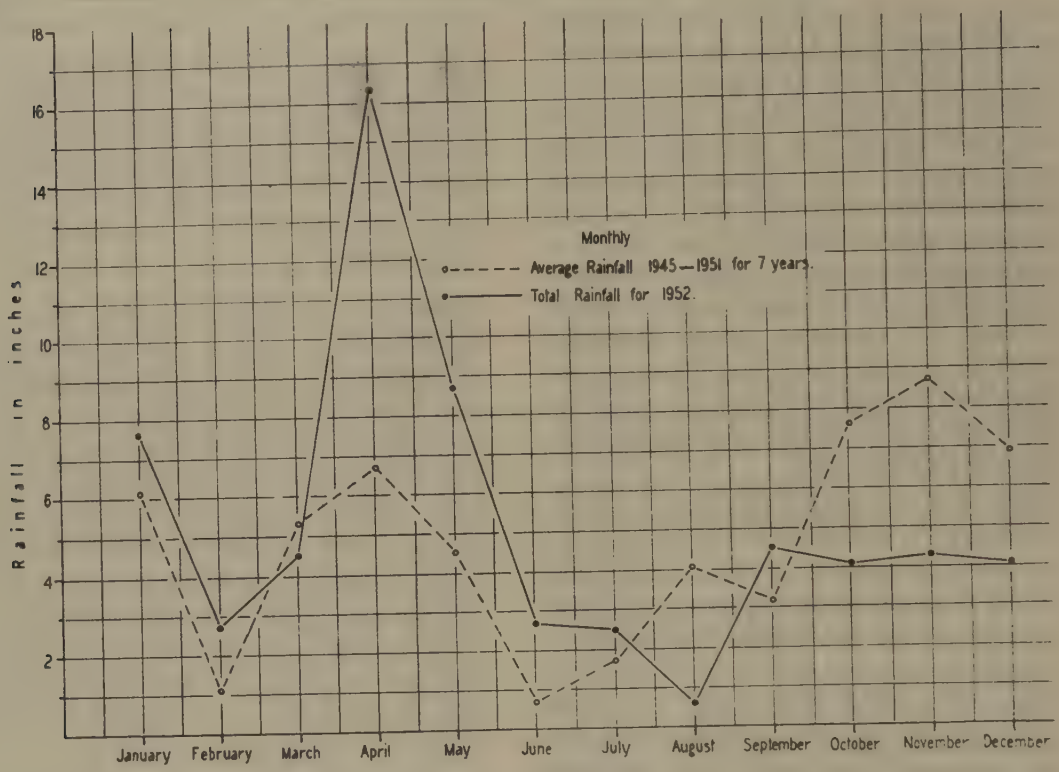


FIG. I—Rainfall Graph.

No appreciable control of early blight appears to have been produced. It is, however, presumable that this light infection represents the development of latent infection which occurred before spraying began. At this stage, however, late blight was also making its appearance but was confined to the controls, while all sprayed plots were free. Late blight rapidly gained ground subsequently but the greater infection was in the unsprayed controls. Table II shows the position of the plots as regards late blight infection on March 27, 1952.

Table II—Average number of plants infected with Late Blight on March 27, 1952

Treatments	*Perenox*		*Cupravit*		*Bordeaux mixture*		*Unsprayed control*
Weekly or fortnightly	W.	F.	W.	F.	W.	F.	
Late blight	12·6	9·4	11·4	6·2	8·6	3·0	46·8

FIG. II—*Left:* Plot sprayed weekly with Bordeaux mixture (4-4-40). *Middle:* Plot sprayed fortnightly with Bordeaux mixture (4-4-40). *Right:* Control plot—unsprayed.

By 23rd April, the last date of spraying, nine weekly and five fortnightly sprayings had been carried out. Almost daily rain was experienced during April and the disease spread very rapidly killing off all the plants in the unsprayed controls so that these plots were bare of plants. The sprayed plants were only lightly attacked, the fortnightly sprayed ones, however, showed more infection than the weekly sprayed ones. Fig. II shows the position at this time, of plots sprayed weekly and fortnightly with Bordeaux mixture and an unsprayed control.

The plots were harvested on May 19, 1954, excluding the border rows and the yield recorded. Any badly rotting tubers which could hardly be weighed were discarded. After this the harvest of each plot was separated into 3 grades as follows :—

Grade I—Tubers not passing through mesh of 1½ in. square.

Grade II—Tubers passing through a mesh of 1½ in. square but not through one of 1 in. square.

Grade III—Tubers passing through a mesh of 1 in. square.

Table III shows the yield of the plots of the various treatments and the histogam, Fig. III, the average weights of Grade I, II and III potatoes for each treatment.

From the analysis of variance ; Table IIIA, of the yields for the various treatments the following conclusions may be drawn :—

1. All treatments are superior to the unsprayed control at a high level of significance 0.001. The yield increases for the various treatments are from 52.16 per cent. to 84.11 per cent. over the unsprayed control.

Table III—Yield per Plot in Ounces (Maha 1952)

Blocks	*Perenox*		*Cupravit*		*Bordeaux Mixture*		*Control*	
	Weekly	*Fortnightly*	*Weekly*	*Fortnightly*	*Weekly*	*Fortnightly*		
I	805	800	849	715	827	920	510	
II	894	693	908	600	857	537	464	
III	713	725	835	812	809	791	428	
IV	791	753	844	779	892	736	456	
V	758	506	771	769	774	887	427	*Sig. Diff.* 0·001
Total	3961	3477	4207	3675	4159	3781	2285	
Mean	792·2	695·4	841·4	735·0	831·8	774·2	457·0	207·17

	Perenox	*Cupravit*	*Bordeaux Mixture*	*Sig. Diff. : 0·05*
Mean	743·8	788·2	803·0	80·7

	Weekly	*Fortnightly*	*Sig. Diff. : 0·05*	*Sig. Diff. : 0·01*
Mean	822	735	65·9	89·33

All treatments are significantly better than the control at 0·001 level.

No significant difference between Perenox, Cupravit and Bordeaux mixture.

Weekly spraying better than fortnightly spraying at 0·05 level.

Table IIIA—Analysis of Variance

	Degrees of Freedom	*Sums of Squares*	*Mean Square*	*Variance Ratio*	*F. Value for Significance* 5%	1%	0·1%
Treatments	6	521528	86921	11·36‡	2·51	3·67	5·55
Blocks	4	27211	6803	0·89	2·78	4·22	6·59
Error	24	183646	7652				
Total	34	732385					

‡ Significant at 0·1 per cent.

An increase in yield of this order only serves to emphasize the heavy toll taken by blight from previous potato cultivations where, in the main, no spraying or inadequate spraying has been carried out.

2. Weekly sprayings were significantly better than fortnightly sprayings at 0.05 level.
3. There was no significant difference between the three fungicides used Perenox, Cupravit and Bordeaux mixture.

Yala Season, 1952, July-November

Under the conditions obtaining at Rahangala and its environs two crops of potatoes could be raised during the year. The seasons are chosen to enable the crop to mature in dry weather. The experiment was repeated again in *yala* using for seed, potatoes harvested from the general multiplication area grown in the *maha* season and employing another block of land for the purpose. The same lay out, method of planting and manuring were employed and planting was done on July 9, 1952. The first spraying was on August 30, 1952, and thereafter weekly and fortnightly sprayings were carried out until a total of 10 weekly sprayings were applied. The tubers were harvested on November 6, 1952.

Rainfall. The rainfall curve for the period of growth of this crop, Fig. I, shows that just as much as the precipitation was higher than the average of 7 years for the *maha* season it was generally lower than the average for *yala*. The first incidence of late blight was noticed later in the growth of this crop, i.e., at 10 weeks and the spread was not as rapid.

The rainfall that did obtain, however, was sufficient for the slow spread of the infection so that three months after planting the unsprayed control plots were almost all defoliated. Table IV shows the weights of harvested tubers per plot and Table IVA the analysis of variance.

Results. The results for second season (*yala*) amply confirms in every way those obtained for the first season (*maha*).

1. All treatments are significantly better than the control at 0.001 level.
2. There is no significant difference between Perenox, Cupravit and Bordeaux mixture.
3. Weekly sprays are significantly better than fortnightly sprayings at 0.05 level.

The plot yields for this experiment were graded into Grade I, II and III as for *maha* and the weights of the three grades of potatoes were further subject to an analyses of variance. Tables V, VI and VII give the weights of these three grades for the various plots and Tables VA, VIA and VIIA sets out the analyses for variance. The results for *maha* are on a parallel to *yala* figures and were not statistically analysed to prevent duplication (Fig. III).

Efficacy of Treatments in Relation to Tuber Size

A comparison of the yields of Grade I, II and III enables the following conclusions to be drawn. All spray treatments

Table IV—Yield per Plot in Ounces (Yala 1952)

Blocks	Perenox		Cupravit		Bordeaux Mixture		Control	
	Weekly	Fortnightly	Weekly	Fortnightly	Weekly	Fortnightly		
I	824	704	768	816	840	916	480	
II	904	616	872	896	908	584	436	
III	776	704	696	664	772	752	432	
V	904	736	664	848	816	852	552	*Sig. diff.* : 0·001
Total	4272	3416	3756	3936	4104	3712	2348	
Mean	854·4	683·2	751·2	787·2	820·8	742·4	469·8	210·06

	Perenox	*Cupravit*	*Bordeaux Mixture*	*Sig. diff. : 0·05*
Mean	768·8	769·2	781·6	81·85

	Weekly	*Fortnightly*	*Sig. diff. : 0·05*	*Sig. diff. : 0·01*
Mean	808·8	737·6	66·85	90·59

All treatments are significantly better than the control at 0·001 level.

No significant difference between Perenox, Cupravit and Bordeaux mixture.

Weekly spraying better than fortnightly spraying at 0·05 level.

Table IVA—Analysis of Variance

	Degrees of Freedom	*Sums of Squares*	*Mean Square*	*Variance Ratio*	*F Value for Significance*		
					5%	*1%*	*0·1%*
Treatments	6	487966	81327	10·34‡	2·51	3·67	5·55
Blocks	4	3416	854	·11	2·78	4·22	6·59
Error	24	188789	7866				
Total	34	680171					

‡ Significant at 0·1 per cent.

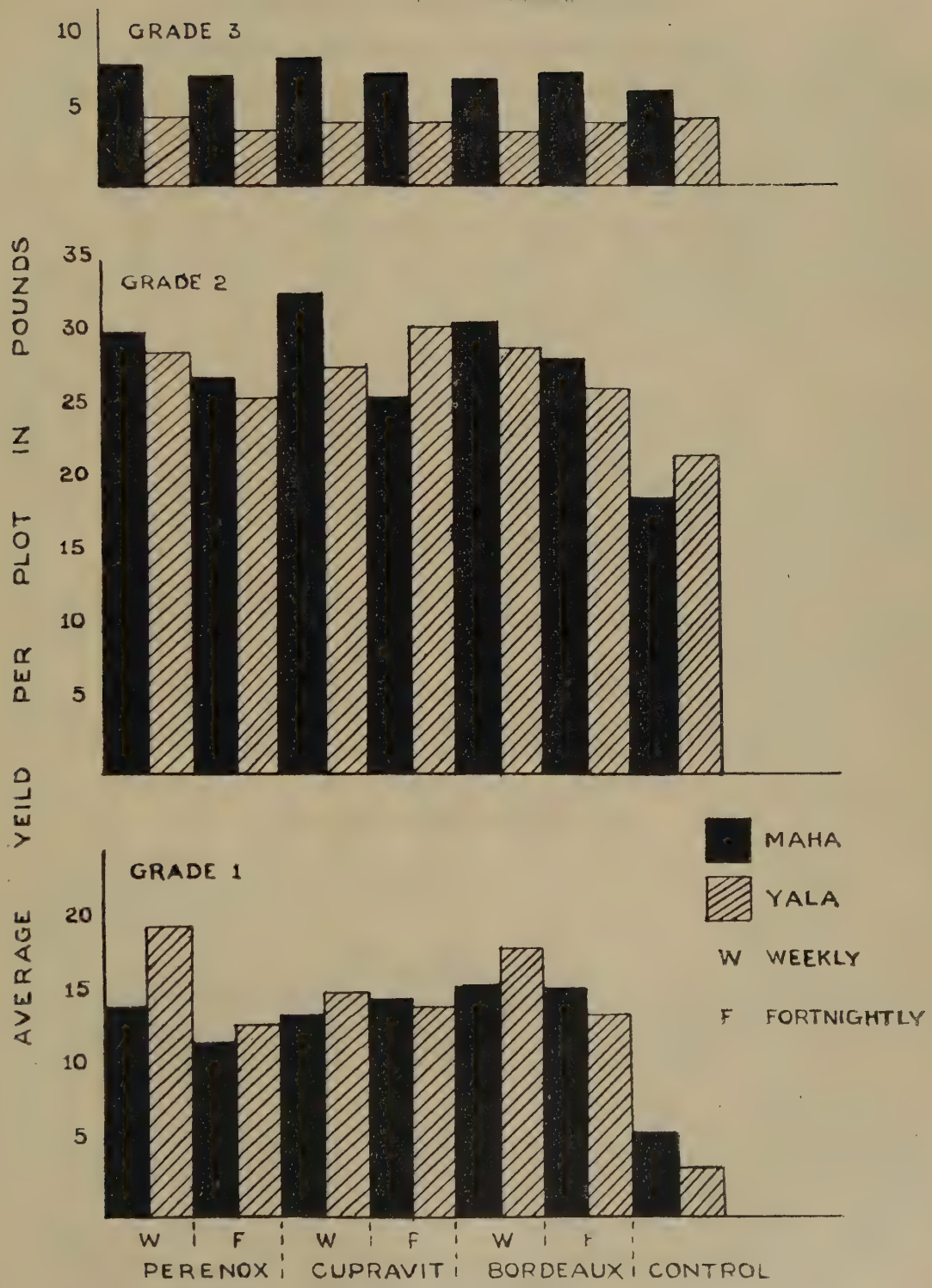


FIG. III—Fungicidal control of Late Blight of potatoes

Table V—Yields of Potatoes of Grade I per Plot in Ounces (Yala 1952)

Blocks	*Perenox*		*Cupravit*		*Bordeaux Mixture*		*Control*	
	Weekly	*Fortnightly*	*Weekly*	*Fortnightly*	*Weekly*	*Fortnightly*		
I	232	256	240	264	288	240	40	
II	360	160	328	240	240	136	56	
III	256	232	200	188	276	224	48	
IV	328	168	272	160	288	192	40	
V	392	232	176	296	376	312	72	
								Sig. diff. :
Total	1568	1048	1216	1148	1468	1104	256	0·001
Mean	313·6	209·6	243·2	229·6	293·6	220·8	51·2	121·15

	Perenox	*Cupravit*	*Bordeaux*	*Sig. diff. : 0·05*
Mean	261·6	236·4	257·2	47·22

	Weekly	*Fortnightly*	*Sig. diff. : 0·05*	*Sig. diff. : 0·01*	*Sig. diff. : 0·001*
Mean	283·5	220·0	38·56	52·25	69·69

All treatments are significantly better than the control at 0·001 level.

No significant difference between Perenox, Cupravit and Bordeaux mixture.

Weekly sprayings better than fortnightly sprayings at 0·01 level.

Table VA—Analysis of Variance

	Degrees of Freedom	*Sums of Squares*	*Mean Square*	*Variance Ratio*	*F Value for Significance*		
					5%	*1%*	*0·1%*
Treatments	6	216720	36120	13·80‡	2·51	3·67	5·55
Blocks	4	17178	4295	1·64	2·78	4·22	6·59
Error	24	62809	2617				
Total	31	296707					

‡ Significant at 0·1 per cent.

show a definitely significant difference at 0·001 level over the unsprayed controls in relation to the Grade I tubers produced. In the production of Grade II tubers too there is a superiority of all spray treatments except Perenox fortnightly, but the level of significance is lower at 0·05. On the other hand the quantity of Grade III or "chat" size potatoes is the same in the sprayed plots and the control, there being no significant difference between them. There is no doubt, therefore, that the most important effect of the spray treatments is the increase in production of the large Grade I potatoes and to a lesser extent in the Grade II potatoes. The histogam (Fig. III) sets this out even more clearly.

Efficacy of Intervals of Spraying in relation to Tuber Size

Weekly spraying shows a definite significant difference over the fortnightly spraying at 0·01 level in the production of Grade I tubers. Apart from this however there has been no difference between the weekly sprayed and fortnightly sprayed plots in the amount of Grade II tubers produced. The same holds for the Grade III size as well. Therefore, under the conditions of the experiment not only are weekly sprays necessary to obtain the highest yield, it is also an important factor in the production of good sized tubers.

Cost of Spraying

The experiment was not designed to explore the economics of spraying and as has been already stated the object was to find out the extent of control possible of the disease. Rather more fungicide than necessary was used but it is possible to get a rough estimate of costs of spraying per acre from the plots as follows. Yields are based on the effective experimental area of 1/435 acre plots which exclude irrigation bunds.

Costs of Spraying at 300 Gallons per Acre

	Rs. c.
Fungicide (Cupravit) 7½ lb. at Rs. 2·50 per lb.	18 75
Spreader, Albolineum 2, 3 lb. at Re. 1·12 per lb.	3 36
Labourer 4 units at Rs. 2·50	10 0
Depreciation of sprayers	2 50
Cost of spraying per acre	34 61

	Rs. c.
For 10 sprayings = 34·61 × 10	346 10

	Lb.
Average yield of weekly sprayed plot	51·36
Yield per acre	22,341·60
Average yield of unsprayed plot	28·56
Yield per acre	12,423
Increased yield due to spraying	9,918

	Rs. c.
Cost of increased yields per acre at 30 cents per lb.	2,689 65

Table VI—Yields of Potatoes of Grade II per Plot in Ounces (Yala, 1952)

Blocks	*Perenox*		*Cupravit*		*Bordeaux*		*Control*		
	Weekly	*Fortnightly*	*Weekly*	*Fortnightly*	*Weekly*	*Fortnightly*			
I	472	368	432	456	480	444	352		
II	480	392	488	584	592	372	324		
III	448	416	432	424	456	448	328		
IV	464	428	424	496	416	352	320		
V	448	448	432	480	376	484	416	*Sig. diff.:* ·001	*Sig. diff.:* ·01	*Sig. diff.:* ·05
Total	2312	2052	2208	2440	2320	2100	1740			
Mean	462·4	410·4	441·6	488·0	464·0	420·0	348·0	116·28	86·85	64·09

	Perenox	*Cupravit*	*Bordeaux Mixture*	*Sig. diff.: 0·05*
Mean	436·4	464·8	442·0	45·41

Weekly	*Fortnightly*	*Sig. diff.: ·05*
456·0	439·5	37·0

All treatments except Perenox fortnightly are significantly better than the control at 0·05 level.
No significant difference between Perenox, Cupravit and Bordeaux Mixture.
No significant difference between weekly and fortnightly.

Table VIA—Analysis of Variance

	Degrees of Freedom	*Sums of Squares*	*Mean Square*	*Variance Ratio*	*F Value for Significance* 5%	1%	0·1%
Treatments	6	64137	10690	4·00†	2·51	3·67	5·55
Blocks	4	9612	2403	·997	2·78	4·22	6·59
Error	24	57838	2410				
Total	34	131587					

† Significant at 1 per cent.

Although the calculations are based on averages of small plots the margin of profit is too large to leave any doubts regarding the efficacy of spraying and its returns. On the other hand actual spraying on an acre basis is bound to be very much less than the calculated costs of experimental spraying. There is no doubt that the costs of spraying could be still further reduced when the minimum number of sprays per season, concentration of spray fluid, and the spray volume per acre are further explored.

Discussion

The results of the experiments for the two seasons *maha* and *yala* show that spraying has been of great significance in increasing the yields of potato by controlling the damage caused by late blight. During the *maha* season much more than average precipitation was obtained and the reverse was the case for *yala*. In both seasons, however, the climatic conditions were obviously favourable to set up severe infection by late blight and in spite of the lower rainfall obtaining in *yala* it must be considered that the precipitation was sufficient to promote infection. According to Beaumont (3) the conditions favouring an epidemic of late blight are a minimum temperature of 50° F and a relative humidity not falling below 75 per cent. for at least two days. The actual temperatures obtaining at Rahangala are not available but temperatures recorded at the nearest meteorological station (Diyatalawa) give a maximum of 78.9° F and a minimum of 58.1° F for the whole year. It, therefore, appears that the predisposing factors of temperature and rainfall are present during both seasons for the onset of late blight at Rahangala and the crop requires protection during both seasons.

The spray treatments sufficiently controlled the disease during the abnormally wet *maha* with 16 inches of rain during April, the most vulnerable period of the growth of the crop, giving 80 per cent. higher yield over the untreated controls. The indications are that if spraying is thoroughly done late blight could be controlled even in the worst seasons at Rahangala and its environs.

The superiority of weekly sprays over the fortnightly treatments was vindicated not only as regards higher yields but also in the larger amount of Grade I tubers produced. The increased number of sprayings have been amply compensated in the profits obtained, hence the policy of spraying too often rather than too seldom is a sound one.

It will be seen that there was no demonstrable difference obtained as far as yields were concerned between the three fungicides used. There were, however, differences in appearance between the plants sprayed with Bordeaux mixture which were slightly larger in size and deeper in colour than the others. Slightly higher yields were also obtained from Bordeaux mixture although these did not reach the level of significance. Callbeck (4) found that the effects of 4-4-40 Bordeaux mixture and Perenox were the same in the control of late blight but that 4-1-40 Bordeaux mixture was superior to both.

In this connection it is relevant to remember that a high volume of spray was used (300 gallons per acre) with all the three fungicides and it is likely

Table VII—Yields of Potatoes of Grade III per Plot in Ounces (Yala 1952)

Blocks	*Perenox*		*Cupravit*		*Bordeaux Mixture*		*Control*	
	Weekly	*Fortnightly*	*Weekly*	*Fortnightly*	*Weekly*	*Fortnightly*		
I	120	80	96	96	72	72	88	
II	64	64	72	72	76	68	56	
III	72	56	64	52	40	80	72	
IV	72	60	60	56	64	64	88	
V	64	56	56	72	64	56	64	
Total	392	316	348	348	316	340	368	*Sig. diff.: ·05*
Mean	78·4	63·2	69·6	69·6	63·2	68·0	73·6	15·00

	Perenox	*Cupravit*	*Bordeaux Mixture*	*Sig. diff.: 0·05*
Mean	70·08	69·6	65·6	10·64

	Weekly	*Fortnightly*	*Sig. diff.: 0·05*
Mean	70·4	66·9	8·67

Treatments are not significantly different from the control.

No significant difference between Perenox, Cupravit and Bordeaux mixture.

No significant difference between weekly and fortnightly.

Table VIIA—Analysis of Variance

	Degrees of Freedom	*Sums of Squares*	*Mean Square*	*Variance Ratio*	*F. Value for Significance*		
					5%	*1%*	*0·1%*
Treatments	6	887	148	1·12	2·51	3·67	5·55
Blocks	4	3591	898	6·80 ‡	2·78	4·22	6·59
Error	24	3168	132				
Total	34	7646					

‡ Significant at 0·1 per cent.

that the plants received much more than the minimum copper necessary to ensure their protection from the fungus. Large, Beer and Patterson (5) have compared the spray retention capacity of certain copper fungicides and found that after 2-3½ inches of rain 1 per cent. Bordeaux mixture showed 40 per cent. spray retention while that of cuprous oxide and copper oxychloride sprays at the same copper dosage with water soluable dispersing agents was less than 20 per cent. They have also shown that effective spraying against blight under relatively severe incidence can be assured by maintaining a covering of not less than 0·5 mg. copper per 120 sq. cm. over the whole expanse of foliage. All fungicides tested afford equally good control, provided that sufficient applications are made according to the dosage and adhesive properties of the spray material, or both, so that the requisite concentration of copper is maintained. In the present experiments it is possible that the large spray volume and concentration used ensured the retention of at least the minimum copper deposit from all the fungicides used. There is little doubt that the rate of 300 gallons per acre could be considerably reduced without losing efficacy of the spray treatments.

During the experiments for the two seasons the incidence of plants affected by virus diseases has not been of sufficient importance to warrant the conclusion that degeneration of tuber quality occurred due to this cause. Certified seed was used for the first season and from this harvest seed was obtained for the second planting. The absence of a material difference in the yields of the two seasons further corroborates the above observation. On the other hand the very definite decrease in the amount of large tubers produced in unsprayed plots observed during both seasons is indicative of the fact that late blight if uncontrolled or inadequately controlled could cause not only a lowering of yields but also a progressive reduction in tuber size. There is little doubt that the same factor was largely responsible for tuber size reduction observed in previous potato cultivations at other stations mentioned earlier.

Although late blight is amenable to control in the Rahangala area continuous cultivation of potato is bound to bring in its train a number of other diseases for which control is much more difficult. Although the question of accumulation of virus diseases in the seed could be solved by frequent importation of certified seed, steps should be taken to see that bacterial, wart and other diseases do not become established in the soil. It is only with a keen appreciation of and strict attention to the prevention of these diseases that any large scale cultivation of potatoes should be undertaken.

Summary

1. Late Blight seriously decreased yields of potato at Rahangala during the *maha* and *yala* seasons.
2. Control of the disease is possibly by spraying with copper fungicides; weekly spraying being better than fortnightly applications.
2. The spray treatments not only covered the cost of treatment but produced considerable increased yields.

4. Late Blight when uncontrolled has been an important factor in the reduction of the average tuber size in previous potato cultivations under similar climatic conditions.

Acknowledgments

The authors express their appreciation of the ready co-operation extended by Mr. A. L. Johnpulle, Agricultural Officer, Uva Division and by Mr. Norman Goonetilleke, Manager, Rahangala Farm in these trials. They are grateful to Mr. D. M. Rodrigo of the Division of Agricultural Chemistry for his valuable services in the statistical analysis of the results.

References

1. BROWNRIGG, S.—Potato cultivation in Ceylon, *Tropical Agriculturist,* Vol. VIII, No. 3, pages 177-178, 1888.
2. MACMILLAN, H. F.,—*Tropical Planting and Gardening,* pages 312-313, 1948.
3. BEAUMONT, A.—Potato blight and the weather, *Pamphlet, Scale-Hayne Agric. Coll.* No. 40 (1932) ; ibid No. 42 (1933) ; ibid No. 45 (1934) ; ibid No. 46 (1935).
4. CALLBECK, L. C.—A progress report on studies of the varying proportions of lime in Bordeaux mixture for Potato spraying. *American Potato Journal,* XXIV, II, pages 377-381, 1947.
5. LARGE, E. C. ; BERR, W. J. & PATTERSON, J. B. E.—Field trials of copper fungicides for the control of Potato blight II. Spray retention—*Amn. Appl. Biol,* XXXIII, 1, pages 54-63, 1 fig. 1 graph, 1946.

Infestation Control in Stored Rice

STEPHEN S. EASTER

RELATIVELY little attention has been given to the problems of rice storage as compared with the extensive studies which have been made to improve the storage of wheat and maize. It is likely that much of this neglect is due to the usual rapid turnover of rice, which often has two or three crops per year and therefore a short storage life, and to the lack of technically trained personnel in areas of heavy rice production and consumption. Available data, however, show clearly that storage losses of rice caused by insects, fungi and rodents, are frequently very high. Closer studies are likely to disclose losses now being unnoticed.

Infestation in Stored Rice

The insects which attack stored rice are well-known and universally distributed. Greatest losses occur in the milled rice which is most susceptible to damage except when extremely dry. There is a mistaken belief that parboiled milled rice is not subject to insect attack. This has been disproved frequently, but in trade circles the claim is still made. Par-boiled milled rice is more resistant to insect attack than regularly milled rice, but still more susceptible than rice stored in paddy, assuming that the moisture content is comparable in all three forms.

The two most destructive insects of paddy rice are Angoumois grain moth (*Sitotroga cerealella* Oliv.), and lesser grain borer (*Rhizopertha dominica* F.), both of which can penetrate the rice husk. The Angoumois grain moth, however, is limited to infestations of the surface areas in bulk stored paddy since it cannot penetrate deeper than about 12 in. because of its fragile body. The rice weevil (*Sitophilus oryza* L.) is not a serious pest of paddy rice but causes the greatest losses in milled rice. It is frequently found as a secondary pest in paddy, entering through the exit holes of the grain moth. A number of other insects are found in milled rice but are relatively unimportant.

Excessive moisture causes heating and moulding of both paddy and milled rice. Usually rice is harvested with a moisture content about 20 per cent. and must be dried for safe storage generally to about 14 per cent., varying somewhat with local conditions.

Rodents, especially rats, may cause serious damage to rice not only because of the amount they devour, but also because of damage to bags and the fouling of the rice. The species of rat varies with the locality.

Some control of insects and rats has been reported in the Far East, but it is impossible to say how extensively these control measures have been applied. It can be safely stated that much rice now being wasted could be saved at little cost. Emphasis on the control of pests has been on the use of chemicals rather than on good management, a much

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cheaper project which should include rotation of stocks, milling on demand, bulk storage of paddy, controlled drying to safe moisture content and, above all, improved storage facilities.

Methods of Storage

Methods of rice storage vary in different countries. Almost universally farmers store rice for home consumption in paddy and mill it when needed for food. Simple home made containers may be used or the rice may be stored unthreshed in the head. Thus full advantage is taken of the resistance of the unhusked rice to insect attacks or to rapid changes in moisture content after it is dried.

Most of the losses do not occur on the farms but, instead, in the large stocks of rice collected for the needs of the cities or for export. It is these large stocks that should receive first attention in order to reduce losses, for many faults are usually found in existing types of storage.

No single formula for infestation control can fit all conditions or rice storage. Nevertheless, a few basic principles are universally applicable.

Recommendations for Infestation Control

Abundance of insects and rodents is usually the result of a basic flaw in the storage system. Emphasis, therefore, should not be placed on methods of direct insect or rodent control, disregarding the more basic factors which presently provide ideal conditions for the pests. It is not unusual to find, for example, that insect control is attempted with fumigants in a storage area where there is no authority to prevent heavily infested rice from being stacked against the rice just fumigated. Frequently all management control is in the hands of non-technical men, who may accept as inevitable the moderate losses which can be equalized by increasing selling prices.

If work is to be initiated towards reduction of storage losses, the following recommendations, with minor modifications, will furnish a sound basis for operations under practically any conditions.

1. *Recognizing storage as a technical problem.* The solving of such a problem requires technically trained men.

2. *Preventing losses in concentrated stocks.* Primary efforts should be directed at the concentrated rice stocks where the major losses are found.

3. *Store rice in paddy.* Storage of milled rice, except for very short periods, should be avoided without sound technical justification. Milling rice only as needed should be the established practice.

4. *Bulk storage and handling.* The traditional storage and handling of rice in costly bags favors insect attacks and harbours rodents. Bulk storage and handling, of course, cannot be accomplished immediately where sack storage is prevalent, but it should be the ultimate goal of improved storage.

5. *Introducing controlled drying.* This could be accomplished in small installations after studies of cost, quality and processing.

6. *Improvement of management.* Management is a broad term and often misunderstood in regard to control of

losses. Seldom does the trader or non-technical administrator recognize the value of simple means in controlling or reducing loses, such as the following :—

(*a*) In insect and rodent control the most important factor is always one of sanitation or cleanliness. No infested material should be left around to spread infestation.

(*b*) There should always be an identification of the separate lots of stored rice to show origin and time of arrival.

(*c*) There should be a regular rotation of stocks in storage with the oldest always moving first for sale or consumption.

(*e*) Infested rice should be disposed of and not be left in storage to infest new stocks.

(*f*) Incoming infested stocks should not be allowed in storage with clean stocks.

7. *Direct control of infestation.* After action along the lines mentioned above has been initiated, there will be time for direct control of insects and rodents. Properly constructed storage facilities should do much in themselves to control rodents. Proven measures for insect control should be adopted to the needs of the area concerned, but should be carefully scrutinized to determine if they are justified.

RESEARCH NOTES

Inter-relationships of Total Milk Yield, Average Daily Milk Yield and Length of Lactation in Dairy Cattle

It would appear reasonable to assume that the average daily yield and the length of lactation are the two main sources causing variation in the total milk yield of a cow. The inter-relationships of these three characters are therefore being investigated. It has been established that the correlations between total yield and length of lactation and between total yield and average daily yield are 0.44 ± 0.04 and 0.82 ± 0.02 respectively for the Sinhala cattle. The corresponding figures for the Red Sindhi cattle in Ceylon are 0.60 ± 0.02 and 0.78 ± 0.02. These results suggest that among tropical cattle there is a high correlation between yield and length of lactation, whereas under European conditions, the main factor governing the lactation yield is the maximum daily yield, as lactations vary little in length. It would be interesting to know what obtains among European cattle under tropical conditions, and this study is now in progress.

Each of the sources of variation, namely average daily yield and length of lactation, may be visualized as a quantitative variable consisting of a permanent and a temporary component. The permanent components would contribute to form the permanent phenosypic part and the temporary components to form the temporary phenotypic part of the total yield. This approach can be used to break down the variation in total milk yield in tropical breeds into the permanent and temporary components of average daily yield and length of lactation.

P. MAHADEVAN.

Studies in Soya Sauce Production

Investigations on the preparation of Soya sauce by a quick process have given satisfactory results. The beans are softened by boiling in water and then treating with a mould—*Aspergillus oryzae*. The softened beans are digested in a strong solution of brine for 5 weeks with the addition of lactic acid bacteria from curdled cow milk and baker's yeast. The extract obtained from this digest is coloured with caramelized rice. The product on analysis was found to have the following composition as compared with Japanese soya sauce :

	Total Solids %	*Protein* %	*Na Cl* %	*Phosphorus* %	*Calcium* %
Japanese Soya Sauce	38·13	9·44	18·02	·210	—
Sauce prepared in Lab.	32·45	3·63	18·00	·172	·028

It is evident from the above results that the quick method of production brings about incomplete digestion and hence the low protein content as compared with Japanese Soya sauce which is prepared by a long process.

C. CHARAVANAPAVAN.

BOOK REVIEW

"Methods of Surveying and Measuring Vegetation"—by Dorothy Brown (Bulletin No. 42, Commonwealth Bureau of Pastures and Field Crops, Hurley, Berks)

Published by Commonwealth Agricultural Bureaux, Farnham Royal, Bucks, England
35 shillings

THE title of this publication is somewhat misleading. It does not in point of fact embrace all types of vegetation but is limited in its usefulness and application, particularly to grasslands. Parts I and II deal with the botanical and ecological approach to the study of grasslands and Parts II and III with the production and utilization aspects. This review is confined to Parts I and II.

The chapters covering these Parts are comprehensively and concisely written and cover the essentials of the recent research into the systematic study of grassland for the ultimate purpose of range management.

Part I includes a short chapter on the Theory of Sampling by G. M. Jolly which is of a very generalized nature and would have served a more useful purpose if it had established a definite relationship with the rest of the text namely the statistical approach to the ecology and practical study of grasslands.

Part II, Botanical Analysis, is more effectively dealt with and is particulars useful and lucid in its treatment of the ecological conceptions of frequency, density (or abundance) and cover (by area). There is currently much looseness of thought on these fundamental conceptions ; the discussion and correlation of the various methods of determining analyses of vegetation based on these conceptions, is therefore, particularly useful and timely.

The author makes mention of the recent statistical approach to the study of distribution of species in grasslands by Blackman, Ashby and other workers but has unfortunately, not given this important aspect more attention. A whole chapter devoted entirely to the appraisal of the results of recent research in this field would not have been out of place. The techniques adopted in the study of distribution of vegetation by area are admirably dealt with covering the entire range of quadrat, transect and line-intercept methods of study up to the more recent point method originally introduced by Cockayne and now accepted as a statistically sound and very practical method of study. The reviewer feels that the usefulness of this section would have been greatly enhanced by a comparison of the statistical bases of the various methods used, in relation to their practical application in the field.

These criticisms in no way detract from an outstanding publication which should be of great practical value to all researchers in grassland vegetation, particularly in Ceylon where the various types of our grasslands have been inadequately studied, particularly from the practical aspects of range management. Intensive studies of our grassland types, based on proper statistical analyses should be the foundation for any scheme of practical utilization of our grasslands which form by no means an insignificant extent of the vegetation of Ceylon. This monograph should be helpful in stimulating and guiding research in this direction.

R. A. DE S.

"Methods of Surveying and Measuring Vegetation" Parts III and IV—by Dorothy Brown (Bulletin No. 42 of the Commonwealth Bureau of Pastures and Field Crops, Hurley, Berks)

QUANTITATIVE studies of vegetation have progressed considerably in recent decades with improvements in range survey techniques and with greater refinements in actual weight and animal production methods for estimating vegetation.

Parts III and IV of Dorothy Brown's publication review all known methods for estimating and utilizing the amount of vegetation produced by a unit area of land, especially as animal food from grazing areas. To the uninitiated these parts will be hard going and, possibly somewhat confusing on account of insufficient emphasis on what is important. Nevertheless, they contain a wealth of information, which, to those who know the main roads should serve as valuable references.

P. M.

APPROPRIATION BILL, 1954-5

Extracts from the Speech of the Hon. Mr. J. R. Jayewardene, Minister of Agriculture and Food

(Hansard Vol. 18 No. 4, Part 1, 20 July, 1954)

The Hon. Mr. J. R. Jayewardene: I would now go on to deal with the important departments that come under my Ministry for I think it is my duty to give a very full Ministerial statement as to the work that those departments are doing and the policies that we intend they should carry out in the coming year.

Plantation Crops

Let me first deal with the three major commodities upon which the prosperity of Ceylon so largely depends today, namely, tea, rubber and coconut. These commodities are also fortunately fetching the highest prices they have fetched for quite a long time. This has helped us in reducing considerably the deficit in the current Budget.

Tea

As far as the tea industry is concerned, in the year 1953 we produced and exported more tea than ever before. We have the Tea Research Institute which is financed by State funds. We have recently given them an extra cess. The Institute is doing very valuable work in finding out the causes of the diseases that affect the tea industry and the remedies that help to do away with those diseases.

The tea industry is a highly developed and highly industrialized one. It needs very little help from the State. As a matter of fact, the State gets a large amount of help from the industry, about which some of the hon. Appointed Members have been complaining. We are taking special steps to help the smallholder. In the tea industry, unlike in the other industries, the smallholder does not own a large portion of the acreage. Only about 80,000 acres are under the ownership of smallholders. We have, through this House, given funds for the creation of co-operative societies of smallholders of tea. We have permitted the Tea Research Institute to create a Smallholders Advisory Board. Through that Board and the co-operatives we are organizing the smallholders of tea so that they may be able to utilize the best methods of tea cultivation, prevent erosion of their land, produce their tea and sell it at a reasonable price without being exploited by the green leaf factory owner. That movement has just started and most of the hon. Members of this House living in the tea smallholders' areas are members of the Board. I trust that that Board will have the help of the State to organize and assist the smallholder in the tea industry.

The Blister Blight campaign is bearing fruit and we need not think that Blister Blight would cause any serious damage to the tea industry today.

We have changed the sliding scale of duties in December and gone back to the fixed scale of duties. If we did not change it possibly the tea industry would be paying more by way of duties because the sliding scale on the new rise in the price of tea would have brought us more money. But that does not matter. With the fixed scale we leave much less room for operation by dishonest men. It has already brought in a tidy sum to the State.

The tea industry hardly needs too much attention. It is so well organized as to be able to look after itself, and it also looks after us.

Rubber

The rubber industry is now going through a period of replanting with State aid. Those facts are before the House and before the

country. We hope to plant an extent of 65,000 acres in 5 years with high yielding clones. In the year 1953, we replanted about 8,000 acres in rubber. We hope to replant more this year. As the years go on, with our nurseries producing the proper type of seed and clone, we hope to increase the acreage and complete the 65,000 acres in 5 years.

The production of rubber has kept up to the normal scale. Last year the production was 98,610 tons which is in keeping with the normal scale of production. It is an index that the rubber owner is getting an economic price.

With regard to the diseases that affect the rubber industry, particularly odium, we have tried out spraying with wet sulphur. Experiments are being conducted with the spraying of wet sulphur by helicopter. It has been successful in certain areas and, wherever possible, we will use the most modern methods in trying to keep down the oidium disease.

Coconut

Now I come to coconut which is primarily a Ceylonese industry. As you know, a large portion of the coconut industry about 70-75 per cent., of the acreage, is owned by smallholders. Much has been spoken about the rehabilitation of the coconut industry. I would like to divide the problem of rehabilitation into two sections : first, replanting ; secondly, reconditioning. Replanting means either the uprooting of old trees and planting new seeds of a high-yielding variety, or planting altogether new land with high-yielding varieties of seeds. We have given all the aid that the Coconut Research Institute has asked for, not only by granting their estimates of Rs. 500,000, but also by increasing the cess to the very amount they asked for, so that their scheme of providing high-yielding seedlings could be carried out without any obstruction or delay. We hope to replant almost 5,000 to 10,000 acres a year during a period of years so that at least that portion of the land under coconut will have high-yields. We have taken land under the Land Acquisition Act throughout the Island where we hope to create certain colonization schemes for cultivation of coconut. With the help of the Minister of Lands and Land Development we have acquired a piece of land in the very heart of a big jungle in the Chilaw area, which we hope to plant with high-yielding nuts, so that there may not be the danger of pollution with trees of not such good yielding variety. I hope that that campaign would be carried out as fast as possible by the Coconut Research Institute.

Reconditioning is a matter which requires very careful consideration. By reconditioning I mean the provision of subsidies for smallholders for the purchase of manure and barbed wire, for the purpose of applying contours on the land for preventing erosion. As I said, 70 to 80 per cent., of the coconut estates are owned by smallholders and are not managed in the proper way so as to produce the highest yields. This aspect of reconditioning requires very careful consideration. I am therefore in touch with the planting associations in the coconut areas, the Members of Parliament and the Minister of Commerce to find out what we could do in the matter, because otherwise money can easily be thrown away. You can give millions and millions of rupees for buying barbed wire, for subsidization of manure, and so on, but that money may not be utilized in the proper way. I am therefore carefully considering the matter before I place before this House a scheme for the reconditioning of the coconut estates that need reconditioning. I am stressing this point because it might be thought that we have not started a scheme for rehabilitation.

As I said, rehabilitation consists of two parts : replanting with high yielding nuts and reconditioning. Replanting is being carried out as fast as the Coconut Research Institute can do it with all the money they have asked for. Opening up of new lands is also being done on colonization schemes. We are providing all the facilities. I do not think any organization can go faster. With regard to reconditioning, that matter needs careful consideration and it is being attended to by the State.

Minor Crops

Leaving these three main industries, there are a large number of minor products such as cocoa, cardamoms, citronella and coffee. I cannot deal with them individually. But I

would like to mention that on a suggestion made by the hon. Member for Maskeliya (Mr. P. H. C. Silva), I hope to create a Minor Products Advisory Board consisting of members of the Central Board of Agriculture as well as others, so that they may advise the Department of Agriculture and the Ministry about the proper way of assisting these minor products. I hope that ultimately this Board will develop into some institute like the ones which help the three major products, tea, rubber and coconut. This question is still in its exploratory stage. I trust that at the next meeting of the Central Board of Agriculture the Minor Products Advisory Board would be cretaed.

Annual Crops

Paddy

I come then to the other major commodity, that is, paddy. With regard to the cultivation of paddy, we are introducing, for the first time in this Budget, certain steps that have been under contemplation for several years. Hon. Members will be glad to know that we intend to create the nucleus of a paddy research institute. There has been an agitation by several Members for several years in that regard and I have been able to persuade the Director of Agriculture that it is very necessary that a paddy research institute should be created. For a beginning we are separating by way of a Committee stage Amendment, all those research officers who deal with paddy research and putting them under a separate head called the "Paddy Research Section of the Department of Agriculture." I have been in correspondence with the Government of Japan asking them for the loan of the services of one of the recognized paddy experts in the world, Dr. Mitsui. If his services are available, he would be the first head of this institute or the chief adviser of this institute. We hope to create ultimately two institutes: one in the North-Central Province, and one in the wet zone. The dry zone institute most probably would be located at Maha Iluppalama where we have the Dry Farming Research Scheme which is largely financed by the New Zealand Government. The other would most probably be at Kurunegala in the Batalagoda area in some part closer to the wet zone; but, certainly, one would be at Maha Iluppalama.

I hope that with the creation of a paddy research institute there would be an emphasis on paddy cultivation: as far as the research side is concerned, there would be investigation into the best methods of paddy cultivation, into the best types of seed that are available, and even investigations into the question of storage and the distribution of paddy. I do not say that these things are not being done, but it would not be fair to the industry if we created these institutes in the other three commodities like tea, rubber and coconut and not in the main product under cultivation in Ceylon, paddy.

One of the obstacles that hinder the proper cultivation of paddy in Ceylon is undoubtedly the question of land tenure; land is owned in too small areas or it is owned by a few absentee landlords who give it out under the various systems of cultivation prevalent in Ceylon. We hope to remedy that, firstly by the Paddy Lands Act. That Act has been in operation in two parts of Ceylon, namely in the Hambantota area and the Batticaloa area. The Act requires certain amendments because of the fact that I cannot put it into operation except in a large specified area like a D. R. O's area or a Revenue Officer's area. I cannot put it into application in a smaller area. I am watching the operation of the Act with a view to proposing the necessary amendments. It would take about a year and once we see the working of the Act we will apply it after amendment to smaller areas or bring up the Act for further amendment if it is considered necessary.

In the Hambantota area there has been strong objection to the operation of this Act by the owners of land. They have said that the tenants had got into possession and are ruining the land because the latter feel that there is no obligation on their part to look after the land properly. All that they wish to feel is that they are the owners of the land with which they could do whatever they wish. Two special officers have been posted at Hambantota to study the operation of the Act and to report to the Ministry what amendments are necessary and on how the Act is working.

The second main factor in increased paddy cultivation is undoubtedly intensive cultivation ; that is, all the methods that we are now familiar with such as transplanting, harrowing, weeding, manuring and the choice of seed. Every one of these methods is now being employed on a very wide scale. If hon. Members would read the reports of the Director of Agriculture and the Director of Food Production for last year they will see the extents that are being brought under cultivation with transplanting, harrowing, weeding and manuring. The State gives very liberal subsidies for the purpose of manuring with proper manure. We have found out the proper manure required for use in the various areas of the Island. We have discovered about forty types of pureline seeds and also which type of seeds are best suited for the various parts of the Island. We have evolved a method of distributing that seed. It is working fairly satisfactorily in the North-Central Province but not as satisfactorily in the other areas. However, it should work satisfactorily in other areas too. I am glad to inform you that the latest information I have from the Paddy Research Section of the Department of Agriculture is that they have now evolved a new type of seed, one from Indonesia, which gives an average of about 80 bushels of paddy per acre. It is far and above the yield which other varieties in Ceylon give today, but as we improve in the evolution of that seed and as we distribute it, I hope our yield will increase.

The next thing we are doing is the introduction of the Japanese method of rice cultivation. I have explained to the House what that method is. It has brought fruitful results in India and special officers have been directed to undertake the study of the Japanese methods with a view to propagating it throughout India. We ourselves have sent three officers to Japan who will be back by the end of the year and we hope to get down a few Japanese families to show us their methods. Where we have tried out those methods in our State farms, there has been an undoubted increase of yields and even private individuals who tried out those methods have told us that those methods have yielded better results than the Ceylon methods.

Now I come to the most important part of the intensive cultivation programme of the Government and that is the Guaranteed Purchase Scheme. That scheme which gives an economic income to the peasants has been, I think, the cause of the cultivation of larger areas of paddy and the use of intensive methods of cultivation. We are giving the peasant Rs. 12 for a bushel of paddy which works out to 80 cents a measure of rice. The world price today is 55 cents. The Ceylon peasant gets 80 cents for a measure of rice. A large amount of paddy was produced last year which was four times the amount produced in the previous year. I must say that we are now ready to take over all the paddy that the peasant wants us to buy. We had one or two difficulties. Firstly, we had the difficulty of storage. For that I think the blame should lie largely on the shoulders of the Treasury. When I was there, applications were made by the Ministry of Agriculture on several occasions that money should be provided for stores ; but the Treasury, looking at it purely from the figures provided to them at that time of production, thought that it was not necessary ; but this year the paddy given to the State was four times what was offered to us last year.

Not purely due to increased production. It was due to various reasons ; may be the fact that we increased the price of rationed rice and there was so much of demand outside and the peasants felt that the Government price of Rs. 12 a bushel was better than what the trader gave them. One need not dispute it. The fact is we are offered four times the rice offered to us in 1952. The plan evolved for buying this rice was a voluntary purchase scheme under the Co-operative Agricultural Producers Societies. In deficit areas those societies are few in number and do not function so well as we hope they would. But in the surplus areas these societies are functioning fairly well. In the year 1953 the number of, what are called C. A. P. & S. Societies, was 729 with a membership of 170,314. In Jaffna, owing to the purchase of onions and chillies under the guaranteed price scheme, they are performing a very useful function. On my last visit there I found these societies were flourishing. They were putting up their own

offices, purchasing their own tractors, carrying out mechanized cultivation and they were, generally speaking, in every way prosperous. In the Eastern Province and the North-Central Province I understand that they are doing very well.

The State has given them aid to the extent of Rs. 45 million—not a small sum. Of the Rs. 45 million, Rs. 27 million has been paid back and we are hoping that at least a large portion of the balance would come back when the crops are good.

We are hoping that this voluntary peasant organization of C. A. P. & S. Societies would be able to purchase paddy on behalf of the State. Only parts of the Island have failed to organize such societies, and I was wondering whether I could not fall back on the headman system to purchase the paddy because if the State says: "We will purchase your paddy at Rs. 12 per bushel" every bushel which the peasant wishes to sell must be bought by us. We must have an organization in order that this may be done satisfactorily. We have not got all the C. A. P. & S. Societies we require. I have therefore asked my officers to circularize the District Agricultural Committees and find out whether it would be possible for the headman to play a part purely as voluntary purchasers as was done under the compulsory purchase scheme.

It is necessary that there must be a proper organization. If a peasant wishes to sell his paddy there is the C. A. P. & S. Society of which he is a member. If the C. A. P. & S. Society cannot buy, there is the headman who comes under the Government Agent or the Revenue Officer who is part and parcel of the Food Commissioner's Department.

I think it will be useful if this purchase scheme for paddy is put under the Food Commissioner. It is now under the Marketing Commissioner. This is necessary because the Food Commissioner is the authority who imports and distributes. It is under the Food Commissioner that the various provincial officers function as Government Agents for the purpose of distribution. It is they who have got to see to the collection and distribution but the key to the solution is that the headman should also be made a sort of purchasing agent. That was my own view. I do not know what the District Agricultural Committees would report. When their reports do come back we will try and evolve some scheme with the help of Parliament.

But what I do want to achieve is this and I have not been able to achieve it this year. A peasant who has an extra bushel of paddy which he wishes to sell to the State, wherever he is, should be able to dispose of it at Rs. 12 without being exploited by traders who may offer him less.

Then, Mr. Speaker, there was the recent crop survey of Mr. Koshal who was lent to us by an International Organization. I need not comment on that report except to say that for the *maha* of 1952-53 his calculation was that our production per acre averaged 26 bushels of paddy per acre throughout the Island.

Our short term plans therefore, for the increase of paddy, were, as I have outlined, the provision of better seed, the provision of better implements such as ploughs, intensive cultivation by the adoption of such means as manuring, harrowing, transplanting and so on. Then there is also subsidization of fertilizers and construction of irrigation schemes—not these big irrigation schemes of the Minister of Lands and Land Developments, but small schemes. We have given instructions to the Director of Food Production that he should release all money available for repair and construction of small irrigation schemes. We have also taken steps in regard to the subsidization of wells, particularly in Vavuniya and the Northern Province, where more cultivation is so necessary. Then there is subsidization of farmers through the purchase of paddy through C. A. P. & S. Societies. Then there are competitions organized and propaganda carried out. We are giving special aid for organizing exhibitions and for carrying out propaganda so that the cultivator may feel that the State is taking some interest in him and showing him the best methods.

I should like to announce that in December, 1955, we will be organizing an All-Island Food and Agriculture Exhibition which will show the agricultural progress in Ceylon from 1931 to date and the latest methods being used as well as the result and progress achieved by the use of those methods.

There are two other matters which need a little attention. Firstly, there is the question of pest control, and secondly, the question of mechanized cultivation.

Now, pest control is assuming large proportions in Ceylon. There is no doubt that unless you make the most advanced methods of pest control available to the peasant all the other steps we are taking of intensive cultivation and subsidies will be of no avail if pests destroy all the efforts he puts in during the year.

We found recently in the Hambantota area that a pest called the pentatomid bug was attacking large extents of fields on the right and left banks of the Walawe Ganga. We utilized the most modern methods. We sent out a helicopter which surveyed the area affected by this pest. If it was necessary the helicopter was to be used in order to spray insecticides and germicides which are in use today. Whether it was used or not I do not know. But if necessary helicopters would be used throughout the Island.

We have, with the aid of Canada under the Colombo Plan received a large amount of material, such as, mobile vans of the most modern types together with sprayers and chemicals. It is my intention to open up ten pests control units for the various provinces in the Island. Two of these units will be stationed in the Eastern Province—one for Trincomalee and one for Batticaloa—the remainder will be kept at various key points in the Island.

Today, we have only one unit in Peradeniya and there is too much centralization. When a pest attacks a cultivation the District Agricultural Officer or Government Agent has to get in touch with Peradeniya and by the time the unit leaves Peradeniya and gets to work in the affected area the pest has destroyed the entire cultivation.

We hope to effect some decentralization with the aid of this equipment from Canada. There will be a unit in each province and the Chief Agricultural Officer will have trained personnel under his command together with chemicals and so on, so that this unit could proceed immediately to the battlefront in order to fight the pest.

I have written to the Hon. Minister of Lands and Land Development asking him to make available in the larger colonization schemes small airstrips so that I could send Auster airplanes if they are necessary for the fighting of pests.

Finally, I want to say a few words about mechanized paddy cultivation. This is a question on which there has been agitation both in the Press and on public plaforms. I would like to say that from the inquiries and investigations I have made mechanized cultivation has not only come to stay in Ceylon but I think it is doing well.

There are four units of mechanized cultivation in Ceylon. There is firstly the private individual over whom I have no control. He orders his own tractors and works them or he hires them as he wishes. That is entirely his private concern.

The Director of Food Production was gifted with about 190 tractors through the good offices of the Australian Government under the Colombo Plan. Now some of these tractors have been given to Agricultural Committees and some to the Gal Oya Board. Some others have been given to various Government departments and the balance is being made use of through the Director of Food Production by the various tractor units throughout the Island. The major tractor unit, the Kangaroo, is stationed at Anuradhapura. These tractors are given out on hire. Certain scales of hire have been laid down for these tractors. We are training engineers, technicians and drivers to work these tractors. If the driver will treat his machine with consideration, mechanized cultivation can be made a success. The Director of Food Production is now putting his tractor units into proper order.

The third is the provision of tractor units through the C. A. P. & S. Societies. There has been much criticism about these tractors. Some of them were given to the tractor unit by the Fordson Agency and the Ferguson Agency, and it is reported that some of these units are not functioning well. But from the report I have obtained, specially from the F. A. O. Expert dealing with tractor cultivation in Ceylon, I am satisfied with the position. He says that he was surprised at the amount of work done by

these tractors during the last few years. Since October, 1952, 48,000 acres have been ploughed with tractors, the cost of labour on the land so ploughed and the other work done can be estimated at over a million rupees.

There were almost 250 tractors functioning through C. A. P. & S. Societies in 1953, and the tractor units amounted to 11. Our idea is to make these tractors owned outright by smaller units so that the peasant can easily hire out tractors without tractors having practically to go 10, 15, 20 or sometimes even 40 miles from their station to the destination and back again. That will avoid much deterioration of the machines besides saving on travelling expenses. Of course, when there were many tractors in our hands in the years 1952 and 1953—tractors being new to Ceylon—one could not have expected them to function properly and as effectively as they did in highly-developed countries; but now that we know what a tractor can do, we are trying to evolve implements for tractors which are suited to the conditions in Ceylon. I have created a Mechanized Advisory Board in the Ministry of Agriculture composed of representatives of the C. A. P. & S. Societies, the Director of Food Production, the Department of Agriculture and other private individuals interested in tractor cultivation; and from that Board I hope to draw the necessary knowledge and experience to put mechanized cultivation on a proper footing.

The final unit is that of the Agricultural Department. It is a very small unit dealing with tractor cultivation on Government farms. We also have our main unit of the engineering department now stationed at Ganoruwa, in Peradeniya, and it is performing good service. That is the story about mechanized cultivation. I am only giving the history of these problems on very general lines because I deal with it in more detail during the Committee stage.

Other Crops

With regard to the subsidiary crops, such as yams, *kurahan,* vegetables, the story is an unhappy one. With regard to onions, we know that the Northern Province produces about 75 to 80 per cent. of our requirements. We have stopped altogether the imports of onions from India. We hope that by better cultivation, by choosing the better seasons we may be soon able to be 100 per cent. self-sufficient as regards onions

We also produce chillies to meet about 40 to 50 per cent. of our requirements. But this has not proved as successful a crop as onions. For yams and vegetables—particularly vegetables—we have now a scheme worked out by the Marketing Department to help the vegetable producer by having mobile vans going to various places and shops selling vegetables and buying local produce for supply to hospitals. That is an attempt to help the cultivator to produce vegetables on a planned scale. During certain seasons, there is nothing but *vatakka* available. Two years ago the Marketing Department had to buy tons and tons of *vatakka* and just destroy it because it could not be sold. People would not take *vatakka* even if we paid them money. Production of vegetables should be planned, and that aspect of the matter has also been considered.

I come to the question of tobacco. I must say that we are having trouble with the Tobacco Pact with India because under that Pact we are not allowed to raise the duty on *beedies* or even to restrict the inflow of *beedies* into Ceylon. India has not purchased all the tobacco she promised to purchase and, with the recent tax on Ceylon-grown tobacco, we find that the tobacco cultivator, who was once doing well, is in for a hard time. I have written to the Prime Minister that as soon as possible this Pact with India should be abrogated. As we have to go on till 1955, we should either completely ban *beedies* coming into Ceylon or put a heavy duty on it, so that it may be possible to continue cultivating tobacco with profit. The finest tobacco is grown in Ganewatte and even in the Jaffna area. The cultivator was given all the help by the tobacco companies, which constructed flues and introduced other methods which helped the cultivation of tobacco. The cultivator is not going to do anything next year because of *beedies* coming in. We will abrogate that fact with India as soon as we can and help the local cultivator.

Department of Agriculture

As regards major products and minor products, I should like to speak a few words on the Agricultural Department, its administration, and composition. I have asked the Director of Agriculture to consider, in consultation with his senior officers, whether we cannot split up the department into two main sections or departments. One section or department should purely deal with agricultural research. I find that there are very highly qualified research men in the Agricultural Department whose only ambition is to become the Director of Agriculture, or gain promotion as senior agricultural officers and deputies. When they become purely administrative officers, they are tied down to their desks ; and deal with transfers and appointments, we lose the best brains which have been devoted to research.

So, if we can create an Agricultural Research Department with its headquarters at Peradeniya, where men can spend their whole time doing research work and not be worried about filling administrative offices, I can take away from the Agricultural Department those officers who will apply that research to extension services. For example, the district agricultural officers work in the field and provide extension services to the peasants, who are benefited by the research carried out by these men.

I can combine the extension services of the Agricultural Department with the Department of Food Production and call it the Department of Agriculture and Food Production and thus have two departments —the Department of Agricultural Research and the Department of Agriculture and Food Production. This suggestion is being investigated by the Director of Agriculture in consultation with his staff officers ; and in the course of the new budgetary year, I may be able to place proposals before the Cabinet and this House for consideration.

Research

With regard to research, one of the most important research schemes is now being carried out at Maha Iluppalama near Anuradhapura. That is a dry farming research station. That scheme deals with almost two million acres of non-irrigable land. If proper methods of cultivation cannot be introduced on that land, I do not think we can become self-sufficient in regard to food. This research station is financed by the New Zealand Government, to whom I wish to offer thanks, with a sum of almost four or five million rupees. Hon. Members can see for themselves the progress made under that scheme. I think we will be able to open early next year the first stage of the Dry Farming Research Scheme at Maha Iluppalama. Very important and extensive experiments are being carried on there with regard to land and water utilization and the crops that can be raised. I have already stated that I hope to install there the first Paddy Research Institute.

Then there is general research being conducted on various soils, pests and plants at Peradeniya, and of course we have our specialized research institutes for the tea, rubber and coconut industries.

Extension and Farms

With regard to extension services for the purpose of application of all this research to the work of the peasants, we depend largely on the District Agricultural Officers of whom there is one in each Province. They are the men who organize the entire agricultural work in the Provinces, who see that the peasants get their subsidies and other help from the Department through the Food Production Officers and through Agricultural Instructors and Overseers, and who see to it that the results of research at the head are put into fruitful practice.

We have in that connection also the various farms controlled by the Department of Agriculture. Now these farms have been the subject of much criticism and, I think, the criticism is justified. But it is not fair to blame the Department of Agriculture, because many of these farms are either colonization schemes or food production schemes which were started during the war and were later handed over wholesale to the Department although the Deepartment did not want them. Fortunately for me, the Parliamentary Committee on Agriculture

visited some of these farms, a Treasury Committee visited some of the other farms, and I am now acting on their very valuable reports. Many of these farms which have not been considered necessary are being closed down, others are being reorganized, and I trust very soon that the farms now being managed by the Department of Agriculture would, wherever it is considered they should pay, be a paying proposition.

We are dividing the farms into various heads. There are the animal husbandry farms which deal with the breeding of animals, special breeds being raised at different places : for instance we are seeking to make the Ridiyagama farm a buffalo breeding centre ; at Nikaweratiya we are seeking to breed draught cattle ; at Polonnaruwa we are hoping to breed only various types of Indian cattle, and at Ambawela and Bopatalawa we are trying to introduce the various European types of cattle. At Karagoda-Uyangoda in Matara we are trying to improve the pure Sinhala breed.

The improvement of animal husbandry cannot be done in a year or two ; it takes time. As far as the officers are concerned, they have informed me that they cannot yet say what is the special stock variety that can be introduced into Ceylon or what is the best type suitable for us. Whether it is the pure Sinhala cattle that can be developed by proper breeding to produce the necessary milk, or whether it is the cross breed between the European and the Sinhala or between the Indian and Sinhala varieties, the officers have not yet been able to decide ; experiments are still going on. I have also had discussions with the experts on the question whether the " Cape " breed, which is a cross between cattle introduced from Europe by the Dutch and the Ceylon cattle, can be taken as the standard type to be adopted in Ceylon. They tell me that they are unable to say yet because experiments are not yet concluded ; they are still going on. As far as animal husbandry farms are concerned, though one should not expect them to pay, still they are beginning to pay under the care of a Danish expert, Mr. Ankar, who is seeing to it that the animals are properly managed and that the full amount of milk available is produced. The milk is sold to various hospitals, and hon. Members will see in the Report of the Director of Agriculture statistices in regard to the animal husbandry farms which indicate that all of them without exception, I think, are now paying their way.

Other farms are attached to educational institutions, for example the Horana farm, the Labuduwa farm and the Peradeniya farm. One cannot expect those farms to pay because they provide the practical farm schools for boys and girls and are managed by the Department of Agriculture. My ambition is to see that each Province has one Farm School for boys and one for girls. We have a large number already throughout the Island and in the new Budget you will see that I hope to open a Farm School in the N. C. P. at Kagama and one at Bibile in Uva. We cannot open all these at once ; we want the necessary trained personnel, the grounds and buildings, but wherever possible I am trying to achieve this ambition of a boys' school and a girls' school in each province, and I want to raise the standard of these schools to the standard reached by the Peradeniya Boys' Farm School and the Kundasale Girls' Farm School. Of the others only the Girls' Farm School at Walpita comes up to the required standard. The rest are not provided with special lecturers nor equipped with proper quarters for students to reside ; they do practical work on these farms, for which they are paid, and they only get a course of an year's duration. One cannot say that in these schools they get a proper education in agriculture ; it is only an opportunity given to children of a certain type of peasant to obtain a practical course of instruction in agriculture. However, I hope gradually to raise the standard of these practical farm schools to the standard of the Peradeniya and Kundasale schools. I should like to mention, in passing, that I have directed that in the Kundasale Farm School the girls should all pay a fee from January next year.

Then, Mr. Speaker, there is the very important question of soil conservation. We have now got the necessary trained men. In the Kotmale valley we have divided the area into a number of sections ; there are trained officers already in the field

in contact with the estate owners and with the peasants and showing them the proper methods of soil conservation.

Those are some of the matters that come under the Department of Agriculture, in the Ministry of Agriculture and Food. I must make a reference to the Central Board of Agriculture, the main advisory body which is supposed to be advising the Minister and the Department. I feel that this body does not perform its functions properly because it is so large, it meets so rarely and at its meetings the members do nothing but discuss ; from the point of view of practical use the Board need not function at all. So I am hoping that the Board would split itself into a number of committees sitting in constant session like the Mechanization Advisory Committee which, I, hope, will do the same, and advise the Minister and the Department on all the problems that come within their sphere. I trust that the Minor Products Advisory Board will also function in the same way. I hope to have Boards set up in respect of two other important activities, namely, animal husbandry and poultry farming.

Animal Husbandry

Animal husbandry is a very important branch of the work of my Ministry. I have already outlined to hon. Members how in the various farms we are trying to find out what is the best type of cattle, neat cattle and buffalo, that can be introduced into Ceylon. We are seeking to increase the cadre of the Veterinary Department so that in each Province we may have sufficient men to tackle the various diseases that arise, as they arise. We are seeking to improve the standard of our cattle not only by experiments on our farms but by opening up artificial insemination centres throughout the Island. I might add that wherever we opened these the demand has been so great that we have found that our equipment and our personnel are quite inadequate for the purpose.

Many of the products of the artificial insemination centres have been most successful. We are seeking to improve the breed of cattle by having various areas demarcated as feeding centres. Stray cattle, immature cattle and bad cattle can be removed, and the area sealed off for private cattle which can be brought there and properly looked after and managed. If a villager who has two heads of bad cattle gives them to the department, he can get back good cattle in exchange.

We need proper investigation into the diseases that prevail in Ceylon as far as animals are concerned. We require cheaper cattle food, and fortunately some companies dealing in coconut produce and fertilizers, have produced a new type of cattle food which, I think, we can put on the market at a cheap price. We need to educate the cattle owner and the poultry owner on the proper management of cattle and poultry.

One of the most important steps taken towards the improvement of animal husbandry in Ceylon has been the creation of the Milk Board ; and I am happy to say that, judging from the minutes of that Board, it is setting about its work in a very businesslike and forthright fashion. If we are able to offer a guaranteed price for milk and make of milk an economic product, the standard of animals in Ceylon must naturally improve. A person with a high-yielding cow will know that it is as useful to him as a coconut or rubber tree. When the Milk Board begins its work, organizes distribution on a proper scale, enters the market and buys milk, I feel it will be a most important step taken towards the improvement of animal husbandry.

There is also the Report of Dr. Khorody which has been published, and you will see from it that he feels that, beginning with the City of Colombo, we will be able to store sufficient milk to supply the people.

I have been offered all the milk produced at the dairies at Narahenpita and Welisara which are run by the State. If you want to remove the cattle of private owners to these dairies as is done in Bombay, some distance away from the City, they can be removed to Narahenpita and Welisara ; and we can immediately organize a scheme on the lines of the Bombay scheme. Those are some of the problems connected with animal husbandry and hon. Members will see that the State has not sat quiet. Within the last few months, the State has taken active steps to

improve animal husbandry in Ceylon. Animal husbandry is most important for increasing national income.

In a small country like Denmark, which has half the population of Ceylon, the income from the produce resulting from animal husbandry is twice our income from tea, rubber and coconuts. It is so also with New Zealand, a small country which depends entirely on the produce she gets from cattle. New Zealand breeds goats, cattle and poultry. Therefore why should not the peasant of Ceylon, particularly in the vast coconut-growing area and even in the tea-growing area meet our dairy requirements and produce income as they do in those countries ?

When I was on circuit in Bandarawela, many of the *kanganies* and smallowners of tea told me that they could produce 3,000 to 4,000 pints of milk a day. They said that at present they were producing from 500 to 600 pints a day, and that they were unable to look after their cattle and maintain them for want of the necessary facilities.

Again, in the Kuliyapitiya area, from 300 to 400 pints of milk are wasted daily.

That, Mr. Speaker, is the story of animal husbandry.

Agricultural Education

Finally, I should like to say a few words about agricultural education. I have already mentioned to the House that we have practical farm schools in each Province ; but they only deal with students who have passed the S. S. C. in Sinhalese or English—students from 14 plus to 18 plus. That is a problem the Minister of Education and I must look into. I must admit that I have been somewhat remiss in the matter, but teachers are being given a special agricultural course, particularly at Mirigama, to impart to them an agricultural bias. However, I do feel that we must bring in all students at a very early stage, between the ages 10 to 14 years, and give them an agricultural education. One of the greatest handicaps we are faced with today is that the student in our junior and senior schools forsakes the ways of his father, does not want to go out into the field—may be because he learns English.

I am organizing a big demonstration in harrowing, sowing and harvesting to remedy that state of affairs. The Minister of Education has placed the services of his whole department at the service of the Agricultural Department and, in combination, we are organizing this big demonstration, which will be a sort of picnic. I have written to all the District Agricultural Committees, to all Members of Parliament, the Governor-General and the Prime Minister informing them that the next organized sowing of paddy will be ceremoniously carried out as in the days of our Sinhalese and Tamil kings. We will have the whole lot of State officials, from the Governor-General downwards, taking part in the greatest profession in the world, the *wap magula.*

Tree Planting Campaign

Before I conclude with the agricultural section of my Ministry, I would like to ask the co-operation of all hon. Members in the tree-planting ceremony, the *vana mahothswaya,* which we are organizing in October this year. We have decided to hold that ceremoney in October this year because during that month the whole Island not only a particular part of Ceylon, will be suitable for cultivation. Planting activities can be carried out throughout the Island during October.

The Agricultural Department, the Rural Development Department, the Local Government Department, all Government departments and schools helping in this campaign, will be provided with seedlings not only of fruit trees but also of timber trees so that there may be, firstly, a love of trees inculcated in our people and, secondly, the rich timber resources which are being exploited so ruthlessly may be replaced.

I have asked for assistance from other countries in this matter and I would like to inform the House that every diplomat from other countries has promised to send me trees and plants indigenous to those countries which will grow in Ceylon. That will be part of the campaign which will be commenced in October this year.

Acknowledgments

I think it would be ungracious on my part if I did not thank the Parliamentary Advisory Committee, the Board of Agriculture and the various international organizations, such as the Food and Agriculture Organization, and all the countries interested in the Colombo Plan for the great help they are giving us to increase agricultural products in Ceylon.

Food Imports and Distribution

Then I come to the question of food distribution and food production. I thought of dealing with food distribution first because the remarks I have made already refer, to some extent, to the question of food distribution. In regard to food distribution, the Department of the Food Commissioner (Supplies) and that of the Food Commissioner (Control and Distribution) have been amalgamated into one as the Department of the Food Commissioner. This has saved expense by way of cadre, and so on, and it is functioning quite effectively.

Rice

First of all, I shall start with rice. The position with regard to rice is that, at the beginning of January next year, I will have in stock from our stock piles about 160,000 tons of rice. That is I have in stock almost 100,000 tons more than I need. Under the Burma and China contracts, I have to import 200,000 tons from the former and 266,000 tons from the latter. I am speaking of long tons. That makes a total of 466,000 tons which with the 160,000 tons in stock will amount to 626,000 tons. This year we have purchased under the guaranteed price scheme some 30,000 tons from the Ceylon peasants. That is four times what we purchased from them last year. That also must be added to this stock.

For our rationing scheme as well as for sales outside the ration, we need only about 460,000 tons. On these calculations, I would therefore need next year to import between 100,000 to 125,000 tons less. That is the proposition which I have placed before the Prime Minister and the Cabinet. Of course, we have had good weather this year and that is why the peasants have been able to reap as much as 30,000 tons. But even without that amount, under these two contracts and the stock pile that we have, it would be necessary for us to import about 100,000 tons less next year.

Rice prices are tumbling down in the world. Under the Burma contract, we have to purchase next year at £ 48 per ton. Under the China contract the price this year is £ 49.5.0. I have an offer of 200,000 tons of rice from Pakistan at £ 38 per ton and a mission from Thailand came here begging of us to purchase their rice at £ 38 to £ 40 per ton. I should like to say with regard to Thailand that about 1½ years ago when my food officials went to that country to buy rice, they had to wait several weeks before they could even get admission there. Now when they asked me to buy their rice I was able to confront them with the question "Will you buy my rice?" I have already sold 50,000 tons and I have some more to dispose of at whatever price I can get for it. I find that I have to dispose of it because the people are not eating this particular kind of rice.

The reason why this change has taken place is purely fortuitous, namely, the easing of the war situation in Asia. When we entered into the Burma contract, we did not know how long the China Pact would last if the Korean War assumed more evil proportions. If the Korean War had assumed more evil proportions, not only would we not have had rice from China but the cost of Burma rice would have gone up because the entire population of Asia would have had to turn to Burma for rice. Therefore, we took the precaution of entering into a contract with Burma for that 200,000 tons. Now, with this 200,000 tons from Burma and the 266,000 tons from China we will have enough for our rationing scheme as well as for selling outside the ration at cost price. It is easy to be wise after the event but Government had to take that precaution.

The reason why we took up that position was because we wanted to avoid a situation in which our people would be starving for want of rice. But now the whole position has changed. I do not know how long this

changed situation will last but if it does last, if there are no threats of war and the production of rice continues in Asia under the most favourable circumstances, then I anticipate that the price of rice will drop even below £ 38 per ton.

At the moment, the Ceylon consumer gets rice at 55 cents a measure. That is with a subsidy. If I buy rice at £ 38 to £ 40 per ton, I can sell it to our people at that price without the subsidy. Sooner or later, I hope to do away with making a profit on sugar because unlimited quantities of rice will be available and the price will come down. At the moment, under the Burma contract alone we can get all the rice we want for our rationing scheme as well for our entire needs. The reason why I cannot do away with rice rationing altogether is because I am subsidizing rice at present and that would be a blow to the people. I am buying rice at 70 cents a measure and selling it at 55 cents. At the moment, as I said, we are making a profit on sugar and it is with that profit that I am subsidizing rice. If I can buy rice at 55 cents, I can do away with rice rationing and, what is more, in time to come we may be able to stop making a profit on sugar also and go back to the good old days before the war.

I should like to mention that there has been an unprecedented rice crop in the 1953-54 season throughout Asia. It is estimated that there will be a record yield of 267,000,000 tons of rought rice, that is paddy, as compared with the previous record of 254,000,000 tons. The weather has been unusually favourable all over and there have been record harvests in India, Pakistan, Thailand, Korea, the Philippines, Taiwan and also in Ceylon. Production of rice in the Near East has now increased to about 13,000,000 tons over the previous year. That is the position with regard to rice production in Asia.

We cannot think too far ahead because we do not know how world conditions will change. The position today is that rice is available to the people at 55 cents a measure. Next year after the negotiations with China —As you know, the Minister of Commerce will shortly be leaving for that country—we will have to study the situation and if we can get cheaper rice we will reduce the price to the consumer. Then we will be able to come to a decision as to what the price of rice to our people should be and for how long more rationing should continue. We can also decide whether we should continue to make a profit on sugar or whether the margin of profit could be reduced. I can assure you that whatever discussions take place they will take place in the interests of Ceylon and Ceylon alone—not in the interests of any other country. Whatever decisions we make will be made in the interests of the vast majority of the consumers in Ceylon and not any particular small interest.

Wheat

With regard to wheat, the position is that there are ample quantities of that commodity for sale in the world markets. Wheat flour can be taken off control tomorrow, if necessary. In fact, I am in negotiation with the private dealers to find out whether they are prepared to take over the import and distribution of flour. It is not necessary that there should be all these controls exercised on the import and distribution of these essential commodities unless, of course, it cannot be helped. Government control means that there will be so much of leakage, corruption and all that sort of thing. Whenever the State tries to do something which is good there is so much of blame cast on it and that is why it is better to decontrol these items as soon as we possibly can.

Sugar

The control of sugar also will be stopped the moment I am able to do it. I do not know what will happen if I throw it open to private traders. I shall not attempt to stop the control of sugar until I know what the exact position is with regard to supplies, price, and so on.

Maldive Fish

With regard to maldive fish, the Government has instructed me to give up the State importation of this commodity and hand it over to private importers. I shall have to look into the question whether there will be adequate supplies to ensure an equitable distribution all round.

The Co-operative Movement

That is with regard to importation. With regard to distribution, of local and imported food, I come to the connected question of the co-operative movement. It is through the co-operative movement that we distributed the essential commodities imported or produced in Ceylon. The co-operative movement is one of the greatest movements in Ceylon and the world. Its great ideals, and the sense of independence and patriotism it indicates in all who participate in it, have not been lost in Ceylon. The co-operative movement has helped our people to a great extent to acquire these qualities.

But in every nation, particularly in a nation which has been for three to four hundred years under foreign rule, there are bound to be many black sheep, and particularly in the stores movement those black sheep have crept in and have assumed power in many parts of Ceylon.

Of the 3,400 co-operative stores just now functioning in Ceylon today—originally there were about 4,000—reports indicate that 50 per cent. are below standard, in the sense that they do not have audited accounts ; that annual meetings are not held ; that members are uninterested, and that there are defalcations and complaints against them.

Applying those standards—a certain rigid set of standards has been laid down—I have instructed the Assistant Commissioners to go round every co-operative store, in every district, and to report by the end of July what they suggest should be done with the co-operative stores movement in their areas : whether they recommend that certain societies should be closed down—I draw a distinction between societies and stores ;—whether certain societies should be liquidated ; whether the stores should be run by a union ; whether the union should run depots. I have asked these Assistant Commissioner what they suggest should be done with these societies that do not fall within the standards we have laid down.

I have drawn this distinction between societies and stores because it is not my intention to close down stores in the villages. I want the stores to continue to help the villagers to buy what they want.

It is the co-operative society that needs correction. It has become corrupt. In the United Kingdom they have not got 4,000 stores societies. For the whole of London they have only 3 or 4, but these stores societies have a large number of depots working under them. That helps centralization, and brings about better management and better control.

My idea, is, if possible, to limit the number of societies. I would go further and say that it would be a good thing of we can have only 26 stores societies, because there are 26 Assistant Commissioners Districts. I would limit the number to 26 large stores societies doing trade to the extent of between Rs. 20 and Rs. 30 million a year, and, through those societies, depots and stores in each village, managed by the union.

Anyway, till the end of July, until the reports come in from the Provinces, I cannot say what the results of the inquiry would be. I do not mind, once the reports have come in, a Committee of the House, composed of Government and Opposition Members, being created to examine the whole co-operative movement in Ceylon and report to the Government what should be done.

It is a people's movement, dear to the hearts of hon. Members of the Opposition who speak so much of people's movements. Here is a people's movement ; let them examine the movement and tell us what is wrong with it, and we shall apply the remedies they suggest. If the Opposition would co-operate with me I shall suggest to the Cabinet that there should be a Committee of both Houses going round the Island to examine the movement and tell us what should be done about this co-operative movement which is so important to the future of Ceylon.

Apart from this stores movement, there are 76 different types of co-operative societies—transport societies, fishing societies, mat-weaving and coir societies, credit societies and so on. With the co-operative stores movement, the number will add up to 77 different types of societies, a number unequalled in the World.

Apart from the stores movement and some of the C. A. P. and S. societies, where large sums of money are involved, I do not think

any complaint can be made against the rest of the co-operative movement. I was in the Matara District about two weeks ago presiding over a meeting connected with the co-operative movement, and I feel that the Matara District is doing well, and so are some other parts of Ceylon.

But we must not hide from ourselves the fact that there is a large amount of corruption in the co-operative movement. We must seek to weed it out. We must turn the search-light on that corruption, and cure and purge the movement from the corruption that has set in.

In some countries, in Denmark for instance, and in the Baltic countries, there is no Department of Co-operative Development at all. It is not necessary, because the co-operative movement is a peoples' movement. I do not know whether that ideal can be reached here, but our Co-operative Department is doing a tremendous amount of good. Some of the junior officers, working in the wilds of Bintenne without houses to live in, go from village to village carrying out their mission of service and help.

While paying a tribute to Government Officials and the Department it would be ungracious on my part if I did not pay a tribute to the great unofficial co-operators, some of them Members of this House. There is a great co-operator behind me, the hon. Member for Panadura (Mr. D. C. W. Kannangara), and there is the hon. Member for Kalutara (Mr. Cooray). There are also great co-operators in the Eastern Province. One of the hon. Members representing Badulla is the President of a Co-operative Union. I am mentioning only a few of the Members who are great co-operators, both on the Opposition side and on the Government side. There is also, the "philosopher of the co-operative movement", the hon. Member for Vaddukoddai (Mr. Veerasingham). We are all co-operators, except in politics!

I must also pay a tribute to those men, not only of our generation but of the past generation, who built up the movement from nothing until it has become one of the wonders of the world. Unfortunately, we grew up too fast. During the War we were propelled with the speed of a jet plane, and the movement must come down to earth, or it may disappear altogether from our ken! To bring it down to its proper foundation, I have asked for an investigation to take place. When that investigation has been made and the report is ready, if the Cabinet agrees, I shall ask that a Committee of the House be appointed to investigate and report on the future of the movement.

With regard to the C. W. E., one report has been received. It will be published. We have entrusted to Major Oldfield, a valued ex-Member of this House, the task of making a further investigation and submitting a report. When that report is published, I trust we shall be able to make up our minds as to the future of the C. W. E.

It is a great organization, and I do not want it to perish, nor do I want to liquidate it. It must go on, and with the recommendations made by these gentlemen we shall be able to cure the defects in the C. W. E.

Marketing Department

Finally, there is the Marketing Department. This is another section of my Ministry which deals with the distribution of food. It was created during the War, and its main purpose then was, firstly, to cook meals to feed the various civil defence personnel—harbour workers, and so on—and, secondly, to help in the systematic marketing of agricultural produce.

The Department has grown from small beginnings until now it has a staff of 1,500 to 2,000. It has various schemes operating, the guaranteed purchase scheme for paddy, schemes for the purchase of onions, chillies and other products coming under the Guaranteed Purchase Scheme. We blame the Department for running its schemes at a loss, but every guaranteed purchase scheme is run at a loss, as an hon. Member pointed out. In America tons of produce are destroyed because the State buys produce at guaranteed prices and is unable to sell it at those prices. In the same way, tons of produce in Ceylon are—not destroyed, but some of it rots.

I have already mentioned the vegetable marketing scheme. It helps the producers to sell their vegetables. We are willing to assist

them as far as we can. In fact I want to help them more. But we need fleets of vans and lorries. We are going to have a number of lorries which will be sent to the various fairs and *polas* to purchase the vegetables and sell them—this is important—at fixed prices in Colombo in the slums and tenements. It will help to keep a tremendous check on the blackmarket trader.

There is also the hospital service, which was very carefully investigated by a committee of experts. They said that the Marketing Department Hospital Service should not be discontinued and that we should not get back to the contract system which is being extended daily now. There may be faults in the service, but it cannot be helped. It may be that the *kolikuttu* is not as big as it should be, or that the hen's egg has got addled. But ultimately and in the final analysis, the distribution of food to the hospitals through the Marketing Department has stood the test of time ; and I doubt very much whether the public, and particularly the patients, would like to see a change.

Then we have the Marketing Department shops in various parts of Ceylon. In Colombo there is a shop where we sell Ceylon produce —not only produce made by the Marketing Department, such as canned pineapples and fruits and coffee, which I found indigestible, but also the produce of others. The Marketing Department is doing good work in the matter of Ceylon produce which it has for sale in its shops. It has also ventured out to another field, namely, canning. It was the present Director of Agriculture who first canned pineapples and fruits in Ceylon. It has now become a thriving industry. We cannot cope with the demand, not only in Ceylon but also from outside, for our canned goods ; and I think that the future of our fruit industry lies in canning. It is said that in Australia they eat the fruits they can and can what they cannot ! That is the only solution.

Take our pineapple industry in Gampaha and the Siyane Korale area, They are growing so much pineapple that it just runs to waste during the pineapple season. We buy as much as we can, and can them for use here even out of season and also for selling outside Ceylon. We intend to introduce a hormone which makes the pineapple grow out of season. That is the modern method used. If that can be done, we could have pineapples growing even out of season. Then we can gradually reduce the cost of the pineapple to the consumer and help the producer to grow pineapples even in the off season and thus develop the industry. This is the main industry of Hawaii and Singapore. But here it is still in a very incipient stage.

We are opening a new canning factory in Borella. The foundation has been laid and I trust we may be able to open it early next year. We hope to install the most modern machinery and thus be able to have it as a pilot factory for canning pineapples, *waraka, jambu, rambuttan,* mangoes and other luscious fruits Ceylon is famous for, including the Pasyala cadju.

I am glad to say that private industry has also taken to canning. One of our well-known politicians, Mr. M. W. H. de Silva, has started such a factory in my electorate, and we are going to give him all possible help by reducing the price at which we sell sugar. It is not fair for us to sell sugar to these small industries at the heavily inflated price at which we sell to the consumers because they cannot compete with the imported stuff or with the stuff we are producing. They have produced some very good stuff which I was able to eat. I was given a few free samples—at the exhibition in Kelaniya, which the Rt. Hon. Prime Minister and I visited—of *waraka* and other edible fruits which are canned by Mr. M. W. H. de Silva and his company.

The object of the Marketing Department, as I said before, is to help systematic marketing arrangements for agricultural produce. It is not our idea to take over the entire marketing in Ceylon. That is quite impossible, for we would disrupt the entire marketing system that prevails here. We want to help orderly marketing and assist the producer to sell his goods at fair prices and not be exploited. The purposes of the Marketing Department are to give the producer a fair price, to sell local produce at a reasonable price, to provide marketing facilities, increase food production and allow the public to have the opportunity of consuming Ceylon products at a reasonable figure.

We are trying to modernize some of the marketing methods by sending some officers, under the Colombo Plan, to Australia and Canada in order to learn the best methods of producing foodstuffs and find out what are the best vehicles for the transport of foodstuffs. For example, pineapples and other perishables are transported in railway vans from Badulla to Colombo. When they come to Colombo they are not recognizable either in smell, colour or taste, because in these hot vans they are all packed and kept for hours without any ventilation. When they reach Colombo they cease to be what they were at the time they were put into the vans at the Badulla Railway Station. So, we are evolving a new type of van, and I trust the expense will not be too much.

In transporting fruits and vegetables, packing is most essential. Take the great industries of Australia and South Africa where they produce the small grape which is such a perishable, delicate article. It comes all the way to Ceylon without even a speck of dirt on the grape. That is what we must try to achieve in Ceylon. I am very sorry to say that our producers have not realized even the elements of packing and storage in the cultivation of fruits and vegetables. We are trying to inculcate that through the Marketing Department.

In regard to storage, we are trying to get a refrigeration plant so that we can keep these fruits in storage to be sold out of season. We are also trying to help the producer to plan out his production so that he need not grow *wattakka, wattakka, wattakka* in season and out of season and dump them into the Marketing Department vans to be brought to Colombo.

I should like to give just two examples of some of the difficulties we now encounter. For instance, the pineapple industry in Gampaha was faced with a very serious disease recently. Fortunately, owing to our modern methods of research and pest control, we were able to bring down the pest control unit and deal with, what is called, the mealy bug. The curious thing about this mealy bug is that it lives on the pineapple and is kept and looked after, strange to say, by the ant. The mealy bug is cultivated by the ant. The ant carries the mealy bug from pineapple to pineapple as a milch cow and takes benefit from this mealy bug. In the course of its life the mealy bug injects poison into the pineapple which causes the pineapple to wilt.

We got down an expert from Hawaii, and as soon as he saw the mealy bug he said "This is my old friend from Hawaii, the mealy bug. In Hawaii we have the same trouble and we cured the disease." He has told us what solution should be applied. Unfortunately that germicide or bugicide is something which is fatal to man. So, we must use it most carefully with modern methods: we will have to use gloves and respirators. We are doing our best, and I trust that the mealy bug would disappear from Ceylon in a few weeks time.

We found the same trouble with regard to the pests in the orange groves of Bibile which at that time were frequented by the presnt hon. Member for Galle (Mr. Dahanayake). What happens is that the peasant is not interested. He does not cultivate the tree, he lets it grow. He plants the seed and lets it grow and when the fruit comes he sells it. He does not manure it, he does not look after it, he does not do anything by himself. But he wants the State to do everything for him. He can hardly be blamed if he does not look into the economics of anything because he is not an agriculturist of the modern type. So what we are proposing to do is to educate such people so that they can use modern methods of cultivation and make them consider the tree as a human, as a friend, just as much as they consider cattle to be friends, and instil into them the idea that it is only proper planting and proper care alone that would bring more fruitful results. Those are some of the ideals which we are trying to achieve in the matter of cultivation and the growing of foodstuffs and fruits in Ceylon.

Then we have also arranged with the Marketing Department to find out what the proper market prices of various commodities are and have them published in all the public places so that the consumer would not be exploited. Then we have our mobile

shops going not only to the chief towns but also to the various fairs and festivals. There is one today functioning at Kataragama which is proving to be of great service to the pilgrims there. And finally we have our Bakery which was performing a very useful service at one time but which is gradually dying down today as a result of the free midday meals that were being provided to the school children being given up. We were providing as many as 2,000 to 5,000 cooked meals a day, and today I saw in the papers that in the case of the meals supplied to one of the Government departments there was found to be a rat—maybe one of the rats which left the sinking ship, according to the hon. Leader of the Opposition. I visited the kitchen only the other day—it was a surprise visit—and I found it very clean and well kept and performing a very useful service.

Those, Mr. Speaker, are some of the matters that I wish to bring to the attention of hon. Members as far as my Ministry is concerned. I have been hardly a year in this office and during that period, unfortunately for 3 or 4 months, I was an invalid. But I have been able to get a grasp of the work and I found it most interesting, if not more interesting than the Ministry of Finance which I have handed with great happiness to my hon. Friend the Minister of Finance. I must congratulate him on the splendid way in which he introduced his Budget.

I trust that hon. Members are satisfied with what I have been able to say in a general way. I have not gone into details because when the Committee stage comes up—when the House goes into it item by item—I hope to give more factual information so that all hon. Members for one, most of them or a majority of them, would be satisfied. That is all that I have to say. I thank you, Mr. Speaker, and the hon. Members for the patient way in which they have listened to my long dissertation.

ANIMAL DISEASES RETURN

April-June, 1954

Province	Disease	Fresh Cases during Quarter	Total Number to end of Second Quarter, 1954				Balance ill at end of quarter
			Cases	Deaths	Shot	Recoveries	
Western Province (excluding Colombo Municial area)	Rabies	68	147	—	147	—	—
	Foot-and-mouth	874	874	19	—	406	449
Northern Province	Anthrax	12	62	62	—	—	—
	Rabies	6	10	—	10	—	—
	Black Quarter	105	116	116	—	—	—
North-Central Province	Foot-and-mouth	117	912	10	—	824	78
	Rabies	—	2	—	2	—	—
	Black Quarter	150	150	150	—	—	—
North-Western Province	Rabies	5	9	—	9	—	—
	Foot-and-mouth	98	98	—	—	80	18
Central Province	Rabies	17	32	—	32	—	—
	Piroplasmosis	1	5	—	—	5	—
	Foot-and-mouth	28	28	—	—	15	13
Province of Sabaragamuwa ..	Rabies	5	9	—	9	—	—
Province of Uva ..	Rabies	—	4	—	4	—	—
Eastern Province	Foot-and-mouth	2,435	2,968	282	13	1,011	1,662
	Mange	86	171	40	—	131	—
Southern Province	Rabies	4	15	—	15	—	—
	Bovine Farcy	—	12	1	—	11	—

Department of Agriculture,
Peradeniya, August 21, 1954.

R. G. MALKANI,
Acting Deputy Director (Animal Husbandry)
and Government Veterinary Surgeon.

METEOROLOGICAL REPORT

April-June, 1954

SUMMARY

INTER-MONSOON thunder activity was well in evidence during April, resulting in excessive rain in the south-western low and mid-country and among the Haputale hills, while considerably heavy rain was experienced on a few days in the above areas as well as in Chilaw District, on account of unsettled weather, caused by low-pressure waves in the Arabian Sea. Rainfall of the latter type occurred on the 21st, 27th and 30th. On the 30th the rainfall was widespread over the Island, and unusually heavy in the south-western low-country, where more than 40 stations recorded falls over 5 inches. In those regions therefore the rainfall generally exceeded 15 inches, several stations recording monthly totals over 25 inches. In the north and the east the monthly rainfall was generally less than 10 inches, while the lowest totals (below 5 inches) occurred in the coastal areas of the Northern and Eastern Provinces. The rainfall was considerably above normal in the south-western low and mid-country, in Chilaw District and among the Haputale hills, where the excesses were generally of the order of 5 to 10 inches. Elsewhere over the Island too, the rainfall was mostly above normal, while slight deficits were found, in places, mainly in the northern and north-eastern parts of the central hills.

Active monsoon weather prevailed over the Island in May. Rainfall was chiefly confined to the south-western parts, where at some stations rainfall was experienced almost daily. On the 28th the rainfall was exceptionally heavy in Galle and Kalutara Districts, about 30 stations recording amounts over 5 inches. This rain was heaviest in the neighbourhood of Galle and resulted in floods which caused much damage to house and property. Greatest monthly totals were found in the south-western low and mid-country, where the aggregates at several stations exceeded 30 inches. From this region there was a rapid decrease in rainfall, monthly totals outside the south-west quarter being mainly below 5 inches. Least rain (totals below 2 inches) occurred in the Northern and North-Central Provinces, in the immediate lee of the hills and in the neighbourhood of Hambantota. About 20 stations received no rain at all. The rainfall was considerably above normal in the south-western low and mid-country, excesses in the neighbourhood of Galle and Matugama exceeding 10 inches. Outside the south-west quarter the rainfall was mostly below normal, the bigger deficits (of the order of 5 inches or more) occurring among the central hills.

Although the south-west monsoon prevailed over the Island in June, the winds were not sufficiently moisture-laden. Consequently, the weather was generally warm and dry, and the rainfall below average, practically throughout the Island. Deficits were considerably high in the south-western hill country and the adjacent mid-country, where stations which normally record 20 to 30 inches received only about half the average. Shortfalls in the south-western low-country ranged from 5 to 10 inches. There were a few isolated excesses on the east side. Highest monthly totals (over 15 inches) occurred in a small area on the south-western slopes of the hills. From this region there was a rapid decrease in rainfall, monthly totals at the south-western coastal stations being only of the order of 2 inches, or so. Very little rain was experienced outside the south-western parts, over 120 stations in the northern half of the Island and in the south-eastern low country receiving no rain at all.

D. T. E. DASSANAYAKE,
Director.

Station	April									May			
	Temperature				Humidity		Rainfall			Temperature			
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)	Total	Offset	No. of Days	Mean Maximum	Offset	Mean Minimum	Offset
	°	°	°	°	%	%	Ins.	Ins.		°	°	°	°
Anuradhapura ..	90·6	—1·1	74·3	—0·2	77	98	11·58	+5·15	18	89·5	—0·5	76·3	—0·5
Badulla	84·4	+0·3	66·6	+0·4	76	95	10·12	+3·12	20	86·6	+1·2	67·8	+1·4
Batticaloa	88·2	+0·3	76·7	0	78	93	5·08	+2·78	11	90·5	+0·2	77·4	—0·5
Colombo	87·9	+0·1	75·8	0	76	91	20·49	+11·42	18	86·3	—0·8	77·2	—0·5
Diyatalawa	78·6	+0·8	61·2	+0·7	80	92	8·32	+1·78	19	79·8	+1·1	62·3	+0·3
Galle	85·8	—0·3	77·3	+0·7	79	89	9·79	+1·08	19	84·7	—0·3	77·6	—0·6
Hambantota.. ..	86·8	—0·9	76·0	—0·3	82	91	6·00	+2·14	12	86·1	—0·8	77·3	—0·3
Jaffna	89·6	+0	81·6	+1·4	72	83	5·57	+3·34	11	87·9	—0·3	82·0	+0·3
Kankesanturai ..	91·1	—	78·9	—	73	91	2·02	+0·48	8	91·6	—	81·6	—
Kandy	86·5	—	69·6	—	74	95	7·79	—	21	84·6	—	70·3	—
Kurunegala	90·0	—1·0	74·8	+0·2	74	93	11·46	+1·55	17	89·3	0	76·4	+0·3
M'Illuppallama ..	89·6	—	74·3	—	73	90	9·54	+2·30	18	88·6	—	76·3	—
Mannar	89·9	—0·4	79·0	+1·0	75	84	6·51	+3·09	11	89·4	—0·2	82·1	+1·3
Nuwara Eliya ..	70·3	—1·0	51·8	+1·9	82	91	5·57	+0·59	17	70·0	—0·5	56·0	+2·9
Puttalam	89·3	+0·1	76·9	+0·9	75	91	9·33	+4·45	16	89·0	+0·6	79·3	+0·4
Ratnapura	91·4	0·2	73·6	—0·1	78	98	17·99	+6·42	25	88·9	—0·2	74·4	—0·5
Ratmalana	88·4	—	76·6	—	74	88	19·60	+9·03	20	87·1	—	78·0	—
Talawakele	76·2	—1·4	58·5	+0·7	83	94	7·54	+1·27	20	74·6	—1·0	60·2	+0·5
Trincomalee	90·5	+1·4	77·7	+0·1	74	89	3·90	+1·77	12	93·4	+1·2	79·2	+0·4

Station	May (contd)					June								
	Humidity		Rainfall			Temperature				Humidity		Rainfall		
	Day	Night (from Minimum	Total	Offset	No. of Days	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum	Total	Offset	No. of Days
	%	%	Ins.	Ins.		°	°	°	°	%	%	Ins.	Ins.	
Anuradhapura ..	76	93	2·70	—0·84	7	91·2	+1·2	75·7	—0·8	66	91	0	—0·73	0
Badulla ..	72	90	1·57	—3·12	8	87·4	+2·0	63·9	—1·5	60	94	0·26	—1·28	3
Batticaloa ..	74	89	1·12	—0·67	5	93·6	+1·3	77·1	+0·6	65	82	0·57	—0·32	4
Colombo ..	81	89	13·78	—1·71	25	85·4	0	78·0	+0·6	76	84	1·81	—6·85	14
Diyatalawa ..	72	86	3·24	—2·82	15	79·4	+1·8	61·5	—1·8	60	81	0·03	—1·93	3
Galle ..	83	86	22·64	+9·97	24	83·5	—0·1	77·7	+0·4	83	86	4·77	—3·67	20
Hambantota ..	84	91	2·37	—1·90	10	89·3	+2·9	77·4	+0·5	73	86	0·70	—1·41	3
Jaffna ..	79	85	3·28	+1·28	4	87·2	+0·5	81·1	+0·2	78	83	0	—0·39	0
Kankesanturai ..	74	87	0·51	—0·98	3	91·7	—	81·0	—	69	82	0	—0·57	0
Kandy ..	73	92	4·70	—	13	82·1	—	70·0	—	72	87	2·73	—	20
Kurunegala ..	76	88	7·35	—0·20	22	87·3	+0·6	76·1	+0·4	71	86	3·63	—3·16	17
M'Illuppallama ..	73	88	1·73	—2·99	5	90·3	—	76·3	—	64	86	0·04	—	3
Mannar ..	74	83	0·01	—1·78	1	88·4	+0·2	80·9	+0·3	74	82	0	—0·36	0
Nuwara Eliya ..	80	88	4·71	—3·76	17	66·3	+0·6	55·8	+0·1	81	83	3·77	—6·66	21
Puttalam ..	75	87	2·28	—1·49	9	88·1	+1·7	79·5	+0·2	72	82	0·09	—1·31	3
Ratnapura ..	82	98	18·16	—2·75	27	89·0	+2·2	74·9	+0·2	74	93	9·19	—9·36	22
Ratmalana ..	76	86	13·93	—2·48	25	86·9	—	79·2	—	71	80	2·05	—6·93	13
Talawakele ..	83	97	8·38	—1·03	18	70·7	+0·1	59·9	—0·5	87	94	6·35	—6·93	27
Trincomalee ..	67	82	2·27	—0·96	3	93·8	+1·5	79·3	+0·2	58	78	0·61	—0·32	3

TROPICAL AGRICULTURIST

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VOLUME CX
NUMBER 4
OCTOBER TO DECEMBER, 1954

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TROPICAL AGRICULTURIST

Volume 110 October-December, 1954 Number 4

Published Quarterly By

DEPARTMENT OF AGRICULTURE
PERADENIYA, CEYLON

Subscription Rates

(Inclusive of Postage)

	Annual	*Single copy*
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Abroad	Rs. 8·00	2·50

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All correspondence and payments should be addressed to AGRICULTURAL OFFICER, PROPAGANDA.

Registered as a newspaper in Ceylon.

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EDITORIAL

Increased Rice Production in Ceylon

WITH THE population of the Island increasing at the rate of over 200,000 persons per annum, the question of the increased production of rice to cope with this increase in population becomes a matter of the greatest importance. At present it is reckoned that about 50 per cent. of the Island's requirements of rice are imported. When it is considered that a few years ago the Island produced only about a third of its requirements, it may reasonably be inferred that there has been a marked improvement in our methods of cultivation and/or that there has been an appreciable increase of acreage under the crop. While it is true that nearly 60,000 acres of land (exclusive of extents under the Gal Oya Scheme) have been brought under irrigation for rice cultivation during the past five years, there is little doubt that an appreciable proportion of the increased production of rice during these years can be attributed to intensified methods of cultivation adopted by cultivators as a result of a guaranteed price and the extension activities of the Agricultural and Food Production Departments. Estimates of yields of rice by crop sampling techniques carried out by the F.A.O. Agricultural Statistician, Mr. R. S. Koshal, on an island-wide basis over five seasons have revealed that the average yield in Ceylon varied from 27 to 31 bushels per acre per crop depending on the season. This is in marked contrast to the previously accepted figure of 14 bushels per acre derived from estimates of yield by headmen on visual inspections of fields. The present average yield does indicate that conditions of paddy production in the Island are not very different to those of other Asian countries except Japan, Formosa and Korea which are in sub-temperate regions, and where yields are from two to three times as high as those of Ceylon and the rest of Asia.

With a view, however, to determining how best rice production can be increased on an economic basis, the Ceylon Government invited a Mission sponsored by the Governments of the United Kingdom and the Commonwealth of Australia under the Technical Co-operation Scheme of the Colombo Plan to visit the Island and report on the matter. The Mission's report issued as Sessional Paper No. 2 of 1955 furnishes authentic information on the present position of rice production in the Island, the various factors limiting crop yields, the prospects of increased output and the methods by which this objective can be attained. The report is worthy of the close study of all those connected in any way with the production, milling and storage of rice in Ceylon. A few of its salient features will, however, be dealt with in this survey. One important point which the report stresses is the question of research in relation to rice production. The Mission strongly recommends the establishment of a Rice Improvement Unit within the Department of Agriculture, this title having been preferred to that of Rice Research Institute because they feel that the scope of the organization proposed by them should include not only the study of fundamental research problems connected with rice but also " the processes

by which the results of such research might reach the individual cultivator in the field in the shortest possible time." They are strongly in favour of a scheme whereby the research and extension services connected with the rice crop are under the same administrative agency. Previous to their visit the Minister of Agriculture and Food had himself, in his budget speech, indicated that it was his intention to set up a Paddy Research Institute in the Island. The particular form this unit was to take and the functions it had to perform were left to the British Rice Mission and to a Mission of two Japanese rice experts under the Colombo Plan to determine. The former have already indicated their views on the matter and this section of their report is reproduced in this Journal for the benefit of its readers. The two Japanese experts are at present in the Island studying the problems at issue with particular reference to the location of the Institute, its scope, technical personnel, etc. With the reports of these expert missions in hand Government would be in a position to arrive at decisions and draw up a blueprint of the research scheme it proposes to establish. In order that this decision should be implemented as early as possible the Ministry of Agriculture and Food, with the concurrence of the Government Planning Committee, has authorized the inclusion of a sum of Rs. 4 million for the establishment of this scheme.

Ceylon has a well-established extension service and one which compares very favourably with that of most Asian and many European countries. In regard to rice research, however, while a good deal has been achieved through the agency of the Research Divisions connected with the crop, there is little doubt that with the numerous activities which the officers comprising these units have been called upon to undertake, rice research has not received the concentrated attention which it requires and which is given to it in countries like Japan where very large numbers of research personnel are engaged on investigational work on the crop. The Rice Improvement Unit will rectify this deficiency and within a few years of its establishment the benefits of a planned and concentrated programme of research should become apparent.

In connection with the question of rice research, reference should be made to an article published in this journal by three Agricultural Instructors of this Department who were sent out to Japan to study the methods of rice cultivation adopted in that country with a view to adapting them, on their return, to local conditions. The experience these officers have gained will be very valuable. But it is clear that the methods which are applicable in a country with very high standards of cultivation, a long day-length which permits of the cultivation of varieties which respond markedly to fertilizers, and where irrigation facilities are assured, will have to be investigated carefully and modified where necessary before they can be integrated with local systems of cultivation. At present there is much enthusiasm in the Island over the adoption of what is popularly known as the Japanese method of cultivation. Even in Japan there are variations in methods of cultivation depending on the district, soil conditions, etc., but its essential features are the use of improved seed, good nursery technique, transplanting at distances adequate to permit intercultivation and weeding, heavy artificial and organic manuring, good

soil tillage, and effective pest and disease control. Till such time as more information becomes available on the benefits of these practices in relation to particular districts, efforts will be made to popularise certain features of the Japanese method which general experience and investigation so far conducted have indicated to be of benefit. These officers will test out these various practices on a fairly large scale at experiment stations and also carry out in various parts of the country demonstrations of cultivation practices which can be adopted locally.

There is little doubt that with the adoption of more systematic and improved methods of cultivation the average yield of paddy can be increased in the Island to over 40 bushels per acre. This is the opinion of the joint United Kingdom-Australian Rice Mission and one which the evidence of recent years tends to confirm. The Mission, however, is of the opinion that in order to get the best results under major irrigation projects the establishment of large scale paddy farms on a commercial basis are very desirable and that this might be achieved either through private agencies or through co-operative organizations. Such units can take advantage of the terrain by the adoption of mechanized cultivation for which the smallholder would lack the necessary resources.

Coupled with the intensification of rice production in developed areas is the extension of acreage under the crop, if the Island is to become self-sufficient in its requirements of rice. The Mission has examined the eight major schemes which it has been proposed to develop within the next few years and, on the basis of various considerations, has determined priorities for the schemes. The question of development projects is one which this Department is not primarily concerned with, but it is clear that even if all these schemes are developed a maximum of only about 380,000 acres will become available for the cultivation of rice. This additional acreage would not of itself be adequate to meet the entire requirements of the increased population and other measures would therefore have to be taken to increase food supplies, apart from intensifying production in existing areas. The Mission suggests one such, viz. the cultivation of upland rice in areas which cannot be made irrigable but which, owing to their topographical situation and moisture status, are suited for this crop. The experience of this Department at the Maha Illuppallama Research Station with the cultivation of upland paddy has been very promising so far, and there is good reason to believe that a fairly large extent of land could be utilized for this type of rice growing in the dry zone and contribute its quota to the food supplies of the Island. More comprehensive investigational work will, therefore, be conducted with this crop on this type of land in future.

It is encouraging to note from the Mission's report that its members are impressed with the efforts of the Departments of Agriculture and Food Production in endeavouring to promote the increased production of paddy in the Island. These efforts are being intensified and it is hoped that the cultivators will, in their turn, co-operate freely in achieving the desired result.

Tropical Agriculturist, Vol. CX, No. 2, 1954

Erratum

p. 84, Table 1—82,962 should read 8,962

A Brief Survey of Rice Production in Japan

A. S. RANATUNGA, L. P. T. DE SOYSA and S. THAMBAIYAH

Geographical Features

Topography. Japan comprises the four major islands of Hokkaido, Honshu, Shikoku and Kyushu and covers a total land area of about 148,000 square miles, extending from 31°N to 45°N. More than three-fourths of this consists of rugged mountainous terrain mostly covered with forests: the cultivable area is thus limited to only 14 per cent. of the total land area. The irrigated rice fields occupy 56.5 per cent. of the cultivated land. Upland or unirrigated rice constitutes only 5 per cent. of the total rice area.

Climate. The rainfall is abundant and well distributed, ranging from 52-112 inches in the main rice growing areas. The day length varies from about 13 hours 10 minutes in April to 11 hours 10 minutes in October, with a maximum of about 14½ hours during the months of May to July. The air temperature during this period is about 16°C, reaching a peak of 26°C in August, Rice is cultivated during this period. Generally only one crop of rice is grown during the year (May-October), and during the winter months the land is utilized for the cultivation of wheat and barley. The ill-drained paddy lands are fallowed during winter. Rice crops in Japan suffer frequent damage from typhoons, cold spells, drought and floods.

Soils. The major soils of Japan may be classified as volcanic and alluvial. Rice fields are generally located on alluvial soils of recent origin. Limited areas are also found on soils of Pleistocene plains and hill sides. About 17 per cent. of the soils of the rice area are degraded.

Rice Fields. These may be broadly divided into two groups according to drainage—(i) 'Dry rice fields', which are well drained and have well established irrigation and drainage systems. (ii) 'Wet rice fields', which are wet throughout the year because of a high water table. Many of the rice fields, however, have been reclaimed and today most of them are of the well-drained type.

Ninety-six per cent. of the lowland rice area is transplanted, and this is made possible by an assured and controlled water supply. Direct sowing is done in parts of Hokkaido and in a few other limited areas. Generally, cultivation is by manual labour as there is a dearth of draft animals. The total number of draft cattle is only about 2 million for about 6 million farmholds. Single animal drawn implements are used for cultivation, unlike in most other South-East Asian countries and this eases the situation somewhat.

In land improvement schemes, emphasis has been placed on the replotting of irregular fields into regular rectangles. As a result, irrigation, drainage and cultivation operations have been made easier, thus increasing the operating efficiency and productivity.

The authors have recently returned from a six months study tour of methods of rice production in Japan.

Varieties

There are two types of rice, namely, Paddy Rice (87 per cent. non-glutinous and 8 per cent. gultinous) and Upland Rice (3 per cent. non-glutinous and 2 per cent. glutinous). The former is cultivated in lowland fields under irrigation, and the latter in upland farms under rainfed conditions.

Intensive rice breeding has been done for over 50 years, and as a result about 80 per cent. of the total rice area today is grown with improved varieties. It is believed that increased yields of from 10-20 per cent. are obtained by growing improved varieties. At present there are 87 varieties recommended by the National Government and 40 varieties by the Prefectural Governments. All these varieties are of the Japonica type which give a high response to manuring. The common varieties have a growing period of 150-180 days.

Early maturing varieties are cultivated in cooler regions such as Hokkaido, Northern Honshu and in other areas frequently affected by typhoons. However, no variety of less than 130 days from seeding to maturity is cultivated.

The regional distribution of varieties has a close relationship with the basic vegetative growth periods, photoperiodic and temperature responses. Besides the distribution of varieties varies according to response to soil fertility, and resistance to diseases or pests. In fertile soils, varieties with short culms and many panicles (panicle number type) which give a high response to heavy manuring are preferred. This type of variety is more resistant to lodging. In poor soils, varieties with long culms and long panicles (panicle weight type) are cultivated. These varieties do not give a sufficient response to heavy manuring and lodge easily. Rice varieties indigenous to Ceylon resemble the panicle weight type varieties morphologically. Recent research work has shown however, that varieties suitable for heavy manuring do not always reveal a close relationship with morphological characters as stated above. All cultivated varieties are non-shattering types.

Nursery Preparation

There are two types of nurseries—Upland and Lowland. Upland nurseries are laid on highland in close proximity to rice fields, and depend entirely on rain water. Only about 10 per cent. of the nurseries in Japan are raised under such conditions mainly in areas where land suitable for wetland nurseries are under winter crops at the time.

The main disadvantages of an upland nursery are (i) sparrow damage, (ii) uneven germination, resulting in the irregular growth of seedlings (iii) high susceptibility of seedlings to Blast disease, (iv) comparatively higher cost in preparation of beds and weeding.

Lowland nurseries are commonly used in Japan. The standard size is 1/25 of the total acreage of field to be transplanted. Generally, winter crops are not cultivated in nurseryland. The first ploughing is normally done in mid-March. The depth of ploughing is about three to four inches. If ploughed

deeper the uprooting of seedlings for transplanting becomes difficult. A second ploughing is done in early May. In cold regions the nurseries are protected with covers of oil paper or vinyl cloth.

Humic manures (compost) are added before the first ploughing, or between first and second ploughings, at the rate of about 30 to 50 pounds per 100 square feet. When the soil is fairly well dried after ploughing it is lightly crushed with a hand hoe.

Inorganic fertilizers are applied before harrowing and irrigation, at the rate of one pound of sulphate of ammonia, one and a half pounds of super phosphate and half a pound of sulphate of potash per 100 square feet two to three days before sowing. The quantity of fertilizer applied however, varies according to the fertility of the soil and the climate. Increases in yield up to 11 per cent. have been obtained by nursery manuring alone. Hence the judicious manuring of the nursery is considered very important. Since phosphate promotes root development, it forms an important ingredient in nursery mixture. The fertilizer is placed shallow and mixed evenly.

Irrigation water is introduced soon after fertilizer application, and the bunds surrounding the nurseries are plastered. Two to three harrowings are done to break the clods and to level the surface. Sometimes puddling is done by hand-rakes. After the soil has settled, water is drained out and the field is divided into beds three to four feet wide, and of any convenient length, by opening shallow ditches six to eight inches wide and two to three inches deep. The soil from the ditches is thrown on to the beds, thus raising the level of the beds one to two inches above field level. The object of sowing the nursery in beds is to facilitate nursery operations.

Seed Treatment

Much attention is paid to the treatment of seed in order to control fungus diseases and to obtain healthy seedlings. The Optimum seed rate is about 20 ounces per 100 square feet. Seed of the previous season is placed for three to five minutes in sodium chloride or ammonium sulphate solution, sp. gr. 1.13 for awnless non-glutinous rice and 1.10 for awned non-glutinous rice. Farmers determine the approximate concentration of the solution by floating an egg as shown in Fig. I.

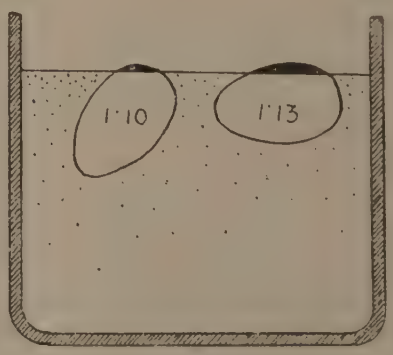


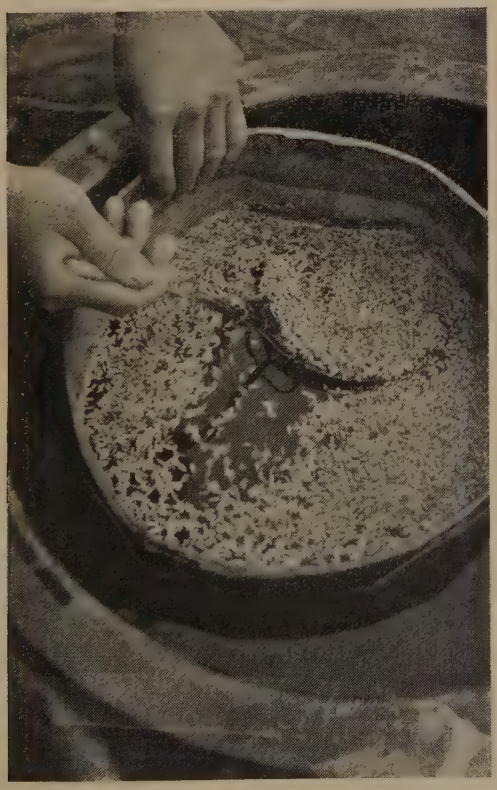
FIG. I.—Diagram showing how to determine the required specific gravity of sodium chloride by floating an egg

All seed that floats is discarded. Good seed is washed thoroughly and immersed in a solution of phenyl mercury chloride (Uspulun), of concentration 1 gr. in 1,000 c.c., of water, for six to seven hours. This treatment is done to reduce the occurrence of fungus diseases. The seed is washed again in water.

The seed is next soaked in water ; the duration of soaking varies with the temperature.

Average Temp.		*Duration of Soaking*
22°C	..	3 days.
25°C	..	2 days.
27°C	..	1 day.

The operation of soaking is discontinued when a few seeds begin to germinate. Generally, seeds are not germinated to the same extent as done in Ceylon in order to prevent damage to plumules and radicles at sowing. In germinating, seeds are not subjected to pressure as done in Ceylon.



Separating the good seed from the bad by immersion in sodium chloride solution

Sowing and Care of Nursery

There are two methods of sowing. In the first method, the beds are flooded with water up to a depth of about one inch and seeds are broadcast evenly on the bed. The seeds are dispersed by the water before settling down. In the second method, seeds are evenly broadcast after draining out water, and are gently pressed into the soil with a light gauze roller or trowel. Great care is taken to scatter the seed evenly over the whole surface of the bed. Sometimes seeding is done in rows.

Irrigation and drainage practices vary considerably with different climatic conditions. Generally about one inch of irrigation water is introduced immediately after sowing. When the seedlings are about one inch high the water level is reduced to help aeration and promote root growth. During this period water is kept only in the dividing ditches to prevent the beds drying. Normal irrigation is resumed after about 10 days and the water level is maintained at a depth of about one inch right through the nursery period. A noticeable feature in nursery irrigation is that only a small quantity of water is used unlike in Ceylon.

Sometimes a thin layer of charred-husk is applied on nursery beds about 10 days after sowing to control weeds and to maintain soil temperature. No weedicides are used, but hand weeding is practised, especially to control *Echinocloa* species (barnyard grass).

The nurseries are not necessarily top-dressed, but if the growth of seedlings is poor, ammonium sulphate is applied at the rate of about one pound per 100 square feet, five to six days prior to uprooting the plants.

As a routine practice, copper fungicides and D.D.T. preparations are sprayed to combat pests and diseases.

Field Preperation

The chief objectives of field preparation are to (i) bury stubble and weeds, (ii) hasten decomposition of organic manures, (iii) mix inorganic fertilizers, (iv) soften the soil for transplanting, and (v) make the soil suitable for the healthy growth of plants.

Ploughing with a single animal-drawn mould board plough

Generally two ploughings are done with a single animal-drawn mould board plough to a depth of four to five inches. The time of first ploughing varies with single or double cropped fields. Compost or farmyard manure is evenly spread at the rate of about three tons per acre before first ploughing. Farmers realize the value of compost, which not only increases the soil fertility, but also supplies the soil with silicic acid and potash, which increases the resistance of rice plants to Blast and other diseases. If green manure such as Chinese Milk Vetch or Soybean is available, it is ploughed in at the rate of 6 to 7 tons per acre, along with 7 to 8 cwt. of quicklime.

A fertilizer mixture, consisting of about 55 lb. nitrogen, 51 lb. phosphates and 51 lb. potash per acre, is broadcast before second ploughing. Generally, the second ploughing is done seven to ten days before transplanting.

It is customary to plough before impounding water. Fields are left dry as far as possible between successive crops to increase the ammonium nitrogen content of the soil. After ploughing in the inorganic fertilizers, water is impounded as early as possible; delayed irrigation results in nitrification of the added ammonium nitrogen. Irrigation is done two to three days after the application of ammonium sulphate, and is never delayed more than a week. In Japan, basic fertilizer is generally applied before irrigation and harrowing.

The bunds in rice fields are very small, usually about 12 inches wide and 10 inches high. All bunds are plastered soon after irrigation. Two to three harrowings are done soon after with an animal-drawn harrow, which puddles and harrows the soil simultaneously.

Harrowing softens the soil, mixes the fertilizers, destroys weeds, helps retention of water and levels the field. Excessive puddling is avoided since the churning action is apt to harden the soil subsequently.

Uprooting Seedlings

Seedlings are uprooted when they are 40-50 days old (in the sixth or seventh leaf stage). The growth rate is slow owing to the low temperature.

Sturdy seedlings with yellowish green leaves and healthy roots are preferred, and those attacked by pests or disease are discarded. Water is impounded to a depth of three to four inches at uprooting time. Seedlings are uprooted one by one carefully and are tied into bundles of 200 to 300 plants. About 1,000 to 1,200 such bundles, which could be uprooted by three units of labour in a day, are used for transplanting one acre.

Transplanting

The transplanting date ranges from the beginning of June in cooler regions to the middle and latter parts of June in warmer regions. In the southern districts planting continues till the middle of July. It is very striking to observe that in any one region, the transplanting operation is completed within ten to fifteen days. This facilitates irrigation and control of pests and diseases. About eight labour units are utilized for transplanting one acre. As a rule, transplanting is done in rows, spaced wide enough to enable intercultivation where hand weeders are used. The spacing between rows varies from about eight to twelve inches and in the row from about four to eight inches. Three plants per hill is common. However, these details vary with variety, soil fertility, climate and cultural practices.

Transplanting is usually done on the square or in avenues. In the square method, the distance between rows and the distance between hills in the row are equal, whilst in the avenue method, the distance between rows is greater than the distance between hills in the row. In the former method of planting there is less competition between plants and tillering is better; hence this method is recommended for heavy tillering varieties in fertile soils and for planting in heavily manured fields. On the contrary, in the latter method of planting, tillering is less owing to greater competition between plants; therefore, this method is practised on poor and medium fertile soils with 'panicle weight type varieties.

Left.—The correct way to hold the seedlings when transplanting
Right.—Transplanting in lines with the aid of a beaded string which serves as marker

At the time of planting about two inches of water is kept in the field. Care is taken to plant the seedlings erect and as shallow as possible, since deep planting tends to delay rooting and reduces the available number of tillers. Planting in rows is done with the help of strings marked with beads or tags at distances depending on the spacing adopted. Some farmers adopt the practice in which two strings marked with beads according to the row distance, are run along the shorter bunds of the rectangular field. A third string marked with beads, according to the hill distances, is held tort along one of the longer bunds, in line with the first set of beads on the side strings. Planting is done along this line at the beads, and is continued by shifting the string backwards along the beads of the side strings. Others adopt the practice in which two strings, marked with beads according to hill distances, are run along the two long bunds and a number of strings, marked with beads according to row distance, are run breadthwise, dividing the field into narrow strips of about four feet wide. Each person plants one strip at a time moving backwards.

Irrigation

After transplanting, water is maintained to a depth of 2 to 3 inches for about one week to facilitate rooting. This is quite contrary to the irrigation practice in Ceylon, where fields are allowed to dry for a few days, immediately after transplanting. The water level is reduced to about one inch, when tillering begins. After the effective tillering stage, about 45 days before heading, it is common practice to drain the fields for 4 or 5 days. This is done for the following reasons :—

(i) At the time of draining, roots are confined mainly to the surface layer owing to the continued submersion of the field, hence drying encourages the roots to penetrate into the deeper layers and thereby increases the nutrient uptake.

(ii) It helps to reduce ineffective tillering.

(iii) It improves the aeration of the soil, thus reducing root damage due to hydrogen sulphide, especially in poorly drained soils.

(iv) Decomposition or organic matter in the soil is hastened, thus increasing the available nutrients.

In fields with very good drainage, this practice is not generally adhered to. However, at no stage in the growth of the crop are fields allowed to dry till cracks appear.

Fields are again irrigated to a depth of about 3 inches and water is maintained till about 20 days after heading. Care is taken to provide sufficient irrigation water from about 30 days before to about 30 days after heading, as all the reproductive processes such as flower initiation, young panicle formation, reduction division, heading and formation of grains take place during this period.

Comparatively less water is used for rice cultivation in Japan than in Ceylon. The average duty of water varies from about 3½ to 5 acre feet, according to the age of the crop.

Intercultivation and Weeding

Intercultivation is the most laborious cultural operation, as it is done purely by manual labour during the hot summer season. This is one of the most important field practices in Japanese rice culture. The main objects of this operation are—(i) to control weeds, (ii) to bury surface organic substances which decompose into ammonium nitrogen easily, and (iii) to promote root activity.

A hand rotary weeder is commonly used for this operation. About ¾ of an acre could be intercultivated in one day by this method using one unit of labour. At present, animal-drawn weeders are under trial. Normally about 2 or 3 intercultivations are done. Fields are drained before intercultivation and weeding and water is let in after the operations are completed. In intercultivating, the weeder in pushed forward between rows, during which the rolling action of the spiked wheels stirs and inverts the soil, and buries the weeds.

The hand intercultivator being used between rows of paddy R

The first intercultivation is done after the seedlings have established themselves (7 to 10 days after transplanting). Cultivation at this stage is considered very effective, especially in fields supplied mainly with artificial fertilizers, whilst in fields rich in ogranic matter, a first intercultivation about 20 days after transplanting is more beneficial. However, from the point of view of weed control, early intercultivation after transplanting is advocated. Another one or two cultivations are done depending on the weed growth. In the third intercultivation weeders are generally not used, to avoid root damage, and the soil around plants is stirred by hand. All intercultivation operations are completed, before the young panicles form—about 30 days before heading.

In about 20 per cent. of the rice area hormone weedicides (2-4 D) are used, and this reduces the cost of hand weeding. 2-4 D weedicides are generally sprayed at the time of the third intercultivation (30 to 35 days before heading), at the rate of 6 oz. in 50 to 60 gallons of water per acre. The water level in the field is reduced to about one inch before spraying.

Recently, the earthing up of plants about 40 to 45 days before heading has been practised in certain areas. Hand-operated or animal-drawn ridgers are worked between rows to earth up. This operation helps to reduce ineffective tillers and also buries weeds. Its beneficial effect is most apparent in ill-drained fields.

Top Dressing

Top dressing with quick acting nitrogenous fertilizers (ammonium sulphate) is practised all over Japan. As much as weeding and intercultivation are necessary to increase the number of panicles, top dressing is essential to increase the number of flowers per panicle. In the basic fertilizer dressing applied to the field before the second ploughing, only a portion of the total nitrogenous fertilizers required is used; the balance is always given as a top dressing. It is estimated that, of the nitrogen supplied as basal dressing, only 30 to 40 per cent. is available to the crop, as compared with 60 to 70 per cent. in top dressing.

The common practice is to top dress at the flower initiation stage. Generally, top dressing is done about 25 days before heading in the case of "panicle weight" varieties, and 30 to 35 days before heading for "panicle number" varieties. If the fertilizer is applied too early or too late it results in ineffective tillering or the plants become susceptible to lodging and blast. Some farmers give an earlier top dressing at the time of the second intercultivation, if the growth is poor. Before top dressing, the fields are partially drained. Sulphate of ammonia is top-dressed usually at the rate of 75 to 100 lb. per acre. Normally the fertilizer is not worked into the soil, if applied 25 days before heading, as tillage operations at this stage damage the crop. However, when early top dressing is done, the fertilizer is worked into the soil by intercultivation. Drainage outlets are closed for a few days after top dressing to prevent the fertilizer from being washed off.

Pests and Diseases

Pest and disease control has received considerable attention in rice production in Japan. Annually about 5 per cent. of the total yield (440,000 tons of rice) is lost due to pest and disease damage, in spite of all the control measures that are adopted. In epidemic years the losses mount to as much as 10 to 15 per cent. of the total yield. An elaborate organization has been set up to forecast outbreaks of pests and diseases. At present there are 580 such forecasting stations scattered over the country. Farmers take effective control measures when warnings of impending outbreaks of pests and diseases are forecast by these stations.

Rice Stem Borer (*Chilo simplex*). This pest does serious damage in cooler regions. It has two life cycles, during the rice growing season. First generation moths emerge about 10 days after transplanting (late June) and the second generation about 30 days before heading (late August).

The pest is controlled by dusting 3 per cent. B.H.C. 3 weeks after transplanting and about 30 days before heading or by spraying Parathion (Follidol) about 2 weeks after transplanting, followed by a second spraying a month later. In addition, field practices such as the removal of egg-masses and attacked seedlings are regularly done.

Paddy Borer (*Schoenobius incertellus*). In southern regions where the climate is warm, this pest is very common. Although it damages the plants in the same way as *Chilo simplex*, the number of life cycles differs. The first moth emergence takes place in the nursery stage, whilst the second and third appear after transplanting.

Spraying with 0.01 per cent. D.D.T. emulsion two weeks after sowing and again a week later, followed by a third spraying of 0.05 per cent. Parathion (Follidol) at the rate of 58 gallons per acre one month after sowing effectively controls the pest in the nursery, so that outbreaks in the transplanted field rarely occur. However, if outbreaks do occur, 3 per cent. B.H.C. is dusted at the rate of about 35 lb. per acre. Great attention is also paid to the removal of attacked plants and egg-masses. When spraying Parathion all possible precautions are taken, as it is highly toxic to human beings and animals. Normally, spraying is done over a wide area on the same day on a co-operative basis. People engaged in spraying wear rubber boots, gloves and masks in addition to their normal field wear which consists of closed-coat, long trousers and rubber shoes. For about 10 days after spraying, no one enters the field and red flags are displayed on the boundaries of sprayed fields, as a warning to keep out.

The common fungus diseases of rice are Blast (*Piricularia Oryzae*), Sesame spot-Helminthosporium (*Ophiobolus-Miyabeanus*) and Sheath Blight (*Corticium Sasakii*).

Blast. This disease does much damage to rice crops, especially during cold weather. Most severe damage is caused when the neck of the ear-head is attacked. Much breeding work is being done to evolve resistant varieties as the Japonicas are very susceptible to this disease. Seed dressing and spraying with Organo-mercuric compounds is done as a preventive measure. The excessive application of nitrogenous fertilizer is avoided as excess nitrogen increases the susceptibility of plants to this disease.

Helminthosporium. This disease occurs mainly in the warmer regions, and on poor soils. A nutritional unbalance in the soil during the vegetative phase that may be caused by a deficiency of silica, pottasium, manganese, magnesium or calcium promotes the disease.

Amelioration of soil is the most effective control measure. Fertilizers containing the Sulphate radical should be avoided. Seed dressing with Organo-mercuric compounds is done as a preventive measure.

The following virus diseases are common :—(i) Dwarf, (ii) Yellow dwarf, (iii) Stripe disease, and (iv) Black-streaked dwarf. All these diseases are transmitted by leaf hoppers, and cause the stunting of plants, discoloration of leaves and sometimes premature death.

The control measures adopted include sparying to destroy the disease-transmitting insects, timely cultivation and the rogueing of diseased plants to reduce infection.

Harvesting

Harvesting is done 40 to 60 days after heading.

The period of maturity is rather long owing to climatic conditions. Reaping is always done with sickles, but attempts are being made to mechanize this operation.

The sheaves are dried by arranging them along wind rows for about 3 to 4 days (if the fields are dry) or in small bundles on racks (if the fields are wet) for 1 to 3 weeks, depending on the weather. At harvest the moisture content of grain is about 20 to 25 per cent. but the drying of sheaves brings down the moisture content to about 16 per cent. Four units of labour could harvest one acre in a day.

The plants are harvested about one inch from the ground as straw is a valuable raw material in the farmer's economy.

Threshing

Dried sheaves are threshed by using pedal or power-driven rotary threshers. The pedal threshing machine only separates the grain form the sheaves, and as such subsequent winnowing is necessary. In the power thresher, threshing and winnowing are done in one operation, hence it is very popular with the farmers.

Threshing is always done in the field if the weather is fine, otherwise, the sheaves are transported to barns for threshing. With the power thresher, the produce of one acre could be threshed and winnowed by 5 units of labour in a day. Winnowed paddy is dried in the sun for 2 to 3 days, at the end of which the moisture content is further reduced to 13-14 per cent. The average yield for the whole country is 75-80 bushels per acre of husked grain.

Labour Requirements for Rice Cultivation

Operations	*Number of Labour Units required per Acre (per Day)*	*Percentage of Total Labour Units employed per Acre*
Seed-bed preparation	6·8	7·76
Field-preparation	15·6	17·3
Uprooting seedlings	3·2	3·6
Transplanting	7·6	8·4
Intercultivation and Weeding	14·0	15·6
Irrigation and drainage	7·2	8·0
Control of disease and pest	6·0	6·7
Fertilizer application	4·8	5·3
Reaping	8·0	8·9
Threshing	7·2	8·0
Drying	4·4	5·0
Husking and packing	5·2	5·6
Total	90·0	100·0

Direct Sowing

Transplanting is the general practice in Japan, but in certain limited areas like Hokkaido, for instance, paddy is sown directly in the field because of the scarcity of labour. Direct-sown paddy land, however, does not exceed more than 4 per cent. of the total rice area.

Seed is drilled in rows, with the aid of hand drills, on fields prepared in the same manner as for transplanting. In some parts, seed is dibbled between rows of wheat and barley, before these corps are harvested. The seed rate is about 25 lb. per acre. Normally, seeds are drilled or dibbled so as to place 10 to 15 per hill. Irrigation, manuring and intercultivation operations are similar to those of the transplanted crop. In Japan, direct sowing in rows has most of the advantages of transplanting, since in both practices intercultivation and efficient weed control are possible. One drawback in this practice is that the seeding operation is laborious owing to the lack of efficient seed drills suited to wetland conditions. The treatment of seed prior to direct sowing is the same as for sowing in a nursery.

The average yield of a direct-sown field veries from 55-65 bushels per acre.

Upland Rice

The area under upland rice is about 350,000 acres. This type is cultivated on highlands as a direct-sown summer crop under rain-fed conditions, in rotation with wheat, barley, sweet potatoes and soybeans. Varieties suitable for upland conditions have been bred. 5 to 8 seeds per hill are dibbled or drilled between rows of wheat or barley spaced 20 in. × 3 in. apart about 2 weeks prior to the harvest of these crops. After

harvesting these crops, compost, farmyard manure, ripened night-soil and artificials are applied to the rice. Sometimes ammonium sulphate is top dressed. Weeding and intercultivation are done 3 to 4 times. At the last intercultivation plants are earthed up. Care is always taken to maintain soil fertility, as often poor yields result due to deficiency of iron and manganese. The average yield is about 35 bushels per acre.

Agricultural Implements and Machinery

Since the unit of the holdings is small, mechanized cultivation is not popular. From the time the crop is harvested, however, all operations such as threshing, winnowing, hulling, polishing and the manufacture of ropes, mats and bags from straw are mechanized. Electric power is commonly used, since about 95 per cent. of the farm households are served with electricity. All cultivation operations are done with a variety of hand- and animal- drawn implements. Recently, power-tillers (2-3 H.P.) and small garden tractors (3-6 H.P.) have become popular. Studies on harvesting machines are in progress, but no practical type of harvester has been designed yet. In the opinion of the authors the ploughs, rotary harrow, hand intercultivator and power thresher discussed in this paper are suitable for trial in Ceylon.

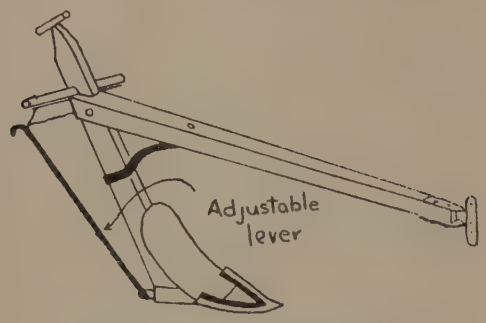
Ploughs. There are three common types, viz., (i) fixed mould board, (ii) reversible mould board, and (iii) double mould board. About 80 to 85 per cent. of the paddy fields are prepared by using these ploughs.

Mould board ploughs have been in use for about 50 years. These are of light construction and are very suitable for field preparation, since they penetrate, invert and pulverize the soil very efficiently. The average weight of a plough varies from 20-30 lb. It is drawn by a single animal and can plough about half an acre in eight hours.

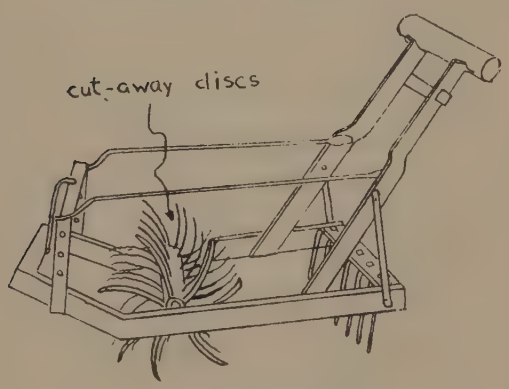
Rotary Harrow. This is a single-animal-drawn implement and is comprised of five to six cut-away discs fixed on a rotary shaft and levelling board. Puddling and levelling operations are done simultaneously. Sometimes rotary-spike or comb-harrows are used. The average weight of the rotary harrow is 48 lb. About 1¼ acres can be harrowed in a day with this implement.

Intercultivators. These are either hand operated or animal drawn. The hand operated intercultivator is more popular and consists of a "U" shaped sledge and two spiked wheels attached to a handle. Its weight is about 10 lb. and it is operated by pushing between rows. About three-quarters of an acre can be cultivated in a day with this implement. (See Figs. on page 258.)

Threshers. Power-driven threshers consist of a two-foot revolving drum, fitted with teeth and a fan for winnowing. These are driven by motor or oil engines of 2 to 4 H.P. Threshing and winnowing are done in one operation. Losses due to unthreshed grains on sheaves and damaged grains are not more than 2 per cent. The processed grain does not contain more than 3 per cent. chaff. There are hand-feed and automatic threshers. Since straw is widely used in Japan for various purposes, paddy sheaves are not passed through the machine. In the hand-feed type, sheaves are held against the rotating drum as in pedal threshers. In the automatic feed type, sheaves in small



REVERSIBLE MOULD BOARD PLOUGH



ROTARY HARROW

HAND INTERCULTIVATOR

bundles are self fed by a rotating toothed chain arrangement. Normally this operation requires four to five units of labour. The capacity of the machine is 20-22 bushels per hour. These machines are very popular with the farmer ; about one million are in use at present.

Agricultural Extension

Co-operation and understanding between the extension and research services together with the willingness of farmers to act on the recommendations of research workers has contributed greatly to agricultural progress.

A large number of extension offices are scattered over the country. Each office is staffed with five farm advisers and one home advisor. One such office caters for about 5,000 acres or about 2,800 farm households. There are over 10,000 farm and home advisors in the extension service today. The farm advisers disseminate new techniques and guide the farmer to improve his economy. The home advisers (women) advise rural women on home management, food and child care. The liaison between the farm advisers and research stations is maintained by Subject Specialists. The duties of these specialists are (i) to study the results of research stations and devise methods applicable to actual farm conditions, (ii) to pass on such methods to farm advisers for dissemination to farmers, (iii) to solve problems which farm advisers may encounter, (iv) to work out seasonal and long-term programmes in consultation with farm advisors for each area, and (v) to acquaint research workers with the farmers' problems that need investigation.

Some of the methods adopted in agricultural extension are as follows :—

(i) Extension advisers frequently visit farms and give individual advice and guidance.

(ii) Group discussions and training courses are encouraged. Experienced research workers and University Professors attend such meetings often to give advice and to gain first-hand knowledge of the farmer's problems.

(iii) New techniques and varieties are demonstrated in farmers' fields.

(iv) Agricultural shows and exhibitions are held regularly to stimulate interest.

(v) Agricultural literature and audio-visual propaganda are widely circulated.

(vi) 4-H clubs and youth training farms are initiated to educate the rural youth.

(vii) Agricultural propaganda is regularly broadcast over the radio. This method is most effective as almost every family possesses a receiving set.

It must be emphasized that the high literacy rate among farmers has contributed immensely to the success of agricultural extension.

Multiplication and Distribution of Seed

There are no seed multiplication stations. Annually 30 per cent. of the seed is renewed and all seed necessary for this purpose is raised in seed farms on selected farmers' lands. These farmers are members of village agricultural associations which are in charge of collection and distribution of all seed produced on these farms. Strict inspection of all seed fields is carried out by technicians who are experienced in seed multiplication methods. The seed produced should conform to the minimum standards of weight, quality and moisture content allowed for each area. The purity and germination percentages have to be 100 and 90 respectively. The farmer is paid a subsidy for all good quality seed produced.

Acknowledgment

The authors express their indebtedness to the Director and Staff of the Kanto Tosan National Agricultural Experiment Station and the Ministry of Agriculture and Forestry of Japan for supplying the relevant data for this paper.

Agricultural Conditions in the Western Division

P. T. JINENDRADASA

Weather Conditions

THE average annual rainfall varies from about 90 in. in the north-western sector to about 160 in. in the south-eastern portion of the Province. Both monsoons are experienced and the wettest periods are April to June and September to November, while the relatively dry periods are January, February and August. The rainfall is distributed badly. about two-thirds the annual precipitation being experienced in five to six months of the year. Often spells of dry weather lasting three to four weeks at critical periods of cultivation delay cultural and sowing operations or impede early growth of crops, while unpredictable, torrential downpours cause much damage through floods, washaways and soil erosion.

Highland Soil Conditions

The surface soil of highlands is generally shallow and gravelly or sandy. In cultivated areas most of the real top soil has been eroded.

The lateritic gravelly soil (" cabooky " soils as they are called popularly) are a feature of the Province. They are unsuited generally for annual crops, but rubber grows well on them. Coconuts grow satisfactorily if manuring is done regularly. Cinnamon and tea are also grown on these soils, but to a very small extent and not very satisfactorily. The colour of these soils varies from greyish yellow to reddish yellow. Drainage tends to be excessive so that crops suffer badly during periods of drought. These soils are acid in reaction (*p*H4.5-5.5) and are very poor in mineral fertilizing constituents. Potash, Phosphoric acid and the exchangeable base contents are very low. Stones and gravel comprise half to two-thirds of the soil mass, while the rest of soil mass is loamy in texture. The iron oxide content of the soil is high and this reduces the value of soluble phosphatic fertilizers, such as superphosphate, which get converted into insoluable compounds almost as soon as they are applied. Generally, these soils are very poor from an agricultural point of view, but they respond to cultivation and manuring—especially manuring with bulky organic measures such as compost and cattle manure.

Sandy soils are common in the area round Negombo. They are found also in the valleys and foothills scattered all over the Province where they appear to have been formed by the deposition of silt and sand from higher lying areas which have been subjected to erosion. The sandy soils are whitish, and quartz sand comprises over 95 per cent. of the soil mass. The soil suffers badly from a deficiency of moisture during dry weather, but low-lying basin-like areas get waterlogged during periods of very wet weather due to impervious layers at depths varying from six to fifteen feet. The soils are very acid (*p*H 4.5 to 5) and are very poor in all plant nutrients. Soil acidity, however, decreases slightly with depth, while total exchangeable bases increase with depth. Coconut and cinnamon thrive in

these soils if the soil is manured adequately and drainage is provided where necessary. Satisfactory crops of vegetables and other annuals cannot be obtained unless the soils are manured very heavily with compost or cattle manure.

Highland Crops

The total cultivable areas and the extents under the different crops according to the Census of 1946 are as follows :—

	Acres
Tea	10,946
Rubber	159,334
Coconut	233,391
Paddy	86,153
Other cultivations	15,652
Total cultivated extent ..	507,617
Land area	903,904

There are 270 estates, each over 20 acres in extent with more than 10 resident labourers ; these estates cover 116,000 acres approximately. In addition there are 1,818 estates, each over 20 acres but having less than 10 resident labourers ; these estates cover about 85,000 acres. There are 90,368 smallholdings (1-20 acres) covering about 262,000 acres while home gardens (less than 1 acre) total 204,139 and cover about 90,000 acres.

Except for vegetables, yams, turmeric and ginger no other annual crops are grown on any appreciable scale as the soil and climate are unfavourable for the cultivation of most annual crops. Even vegetables, ginger and turmeric are not economic if they are cultivated with hired labour. Home gardens are very small in size due to fragmentation over a long period, and are about $\frac{1}{8}$ to $\frac{1}{4}$ acre in extent. They are overcrowded with miscellaneous trees such as jak, breadfruit, arecanut, coconuts, coffee and fruit plants. Annual crops are grown where the shade is least under the permanent crops, while vegetables are mostly grown in *deniyas* (*owitas*). Under these conditions there is very little scope for the extension of cultivated crops on peasants' lands. What is theoretically possible is the removal of superfluous, unproductive trees so that the other trees will have a better chance to grow and produce, and the replanting of these gardens with trees of the highest quality. But in practice it is almost impossible to persuade a peasant to remove an existing tree however unproductive it is. Some extension of coffee, pepper and dioscoreas has been possible in places where the shade was not too dense.

Coconuts

The average production is about 1,800-2,000 nuts per acre per year. It has been only recently that coconut estate owners have started underplanting with selected seedlings, manuring systematically, constructing soil conservation bunds and cultivating their estates. Most plantations are suffering from the neglect of the past. Many estate owners are showing a desire to rear good milk cattle under coconut as the cultivation of improved pastures of *Stylosanthes gracilis* has been found to be practicable ; but what limits development in this direction is the unavilability of good stock and a ready and assured market for the milk.

Rubber

There are about 180,000 acres of rubber in the Province, 70,000 acres of which are smallholdings (less than 10 acres each) covered by about 64,000 holdings.

The value of high-yielding clones (especially budded plants) is being realized only now by peasants and smallholders. Up to 1935, the extent of smallholdings replanted was negligible but after the Replanting Subsidy Scheme an appreciable area of smallholdings is being replanted. Smallholdings suffer badly due to Oidium attack, soil erosion and the lack of fertilizers, so that unless these shortcomings are rectified the full value of improved planting material will not be realized. Most estates have been managed well but the average yield from old areas is not more than 500 lb. per acre as the trees are old and the strains inferior. Systematic replanting has been in progress for some time on most of the larger estates and there is evidence that the new areas will yield an average of over 1,000 lb. per acre under good management. The replanting programme has been stepped up considerably since May, 1954, with the inauguration of the Rubber Replanting Subsidy Scheme.

Tea

This crop is found mainly in the Pasdun Korales (East and West) of the Kalutara District where about 10,000 acres are under it. The average yield is about 400 lb. per acre.

Fruits

Mangosteen, pineapples, rambutans, guavas, sapodillas, plantains and certain varieties of avocados do well in the Province. Except in the case of pineapples there are no large orchards. Most fruit trees exist singly or in small groves scattered throughout home gardens in the Province.

Citrus is shortlived and exhibits chlorosis and unthrifty growth unless it is planted in deep pits and manured heavily with cattle-dung and fertilizer. A survey was made to locate some of the sweet orange trees for which Kotte was famous some years ago, but only four such trees were found (all in one garden) and these too were on the point of death through senility. The explanation given by some of the old cultivators in the area was that in days gone by young trees were planted regularly in the gardens to replace the older trees, but with the movement of the present generation to the towns for work and study, this routine had been neglected.

A similar fate has been overtaking the famous Malwana rambutan. Rambutan trees grow almost wild in the Malwana area and these trees are fertilized naturally by the silt deposited by flood waters of the Kelani river. Sour types of Rambutan grow alongside the high quality sweet types and natural crossing of the flowers is widespread. Steps are being taken to arrest this decline by introducing grafts of superior strains, top working the seedlings growing *in situ*, and encouraging systematic attention to the rambutan groves.

In regard to pineapple about 1,100 acres are under this crop in the Province. The main centres of cultivation are Aluthkuru Korale North B, where about 600 acres are cultivated, Siyane Korale West (Meda Pattu), where about 300 acres are cultivated and Aluthkuru Korale South, where about 150 acres are under this crop. The pineapple holdings vary from plots containing a few suckers to one about 45 acres in extent. The average size of plantation is about 2 acres in the case of those who grow the crop for commercial purposes.

The quality of the pineapples grown anywhere in the Province is excellent. Recently, pineapple wilt disease has been causing much damage. Literature describing how the disease is spread, and the control measures have been sent to most growers ; also centres are being established for the provision of insecticides and spraying equipment for eradication of the mealy bugs which cause this disease. In addition to Government canneries, private canneries are being established to deal with the surplus pineapples during the season.

Mangosteens are found all over the Province but are profuse in the Kalutara District. These trees are not manured or tended in any way. All the grower does is to collect the fruits every season.

Paddy Soil Conditions

Paddy soils vary from sands to heavy clays. Extensive areas scattered throughout the Province have sandy loam soils with a fairly high peat content. This type of soil is common in the Kalutara District especially. The soils of the saline swamps, such as those at Muthurajawela, Attidiya, Sooriyawila and Meegama, are very peaty, and these swamps comprise about 15,000 acres ; as attempts at paddy cultivation are made in these swamps they also are classed as paddy lands. The average yield at Muthurajawela has been about 10 bushels per acre. Extensive areas consist of the so called *karametta* soils. These are highly lateritic, very infertile, stiff soils which dry hard and crack badly even during short periods of dry weather. They are acid in reaction and are deficient in available phosphates. This type of soil is very common in the Colombo District.

Generally, soils are very deficient in nitrogen, phosphoric acid and potash, but in fields which are fallowed for one season nitrogen is not so deficient and one has to guard against too heavy dressings of nitrogen which may cause excessive leaf growth at the expense of grain formation. Soils are acid and *p*H generally varies from 5 to 6, but in the coastal saline marshes which are very peaty the *p*H may be as low as 3.

Drainage in relation to the high rainfall is poor and appears to be the chief limiting factor to high yields. The natural subsoil drainage cannot cope with the heavy precipitations of rain and, therefore, surface drainage channels must operate efficiently if high yields are to be secured. But in most areas these surface drainage channels have got silted up and often they have been *asweddumized* so that run off and floods during periods of heavy rains cause havoc to the growing paddy as well as to the paddy soils. This damage by floods may occur even in the hilly areas if owing to a basin-like topography there is no ready outlet for the rain water.

In the coastal saline swamps (e.g., Muthurajawela) drainage is a real problem because portions of these swamps are below mean sea level and are traversed by water-ways which are connected to the lagoons in the area.

Irrigation Facilities

Most of the area is rain-fed. The only major irrigation scheme in the Province is the Attanagalu Oya Scheme (an anicut scheme in the Colombo District) which was started in 1937, and is nearing completion. It is designed to supplement rainfall in about 7,000 acres for

the *maha* season and, in addition, permits about 2,000 acres of this area (which would otherwise remain fallow) to be cropped in *yala* also.

Minor irrigation schemes (mainly anicuts) supplement rainfall in about 3,000 acres in *maha* and 2,300 acres in *yala* (Colombo District 1,600 acres for *maha* and 700 acres for yala; and Kalutara District 1,400 acres for *maha* and 1,600 acres for *yala*). The balance area cultivated—about 85,000 acres in *maha* and 65,000 acres in *yala*—is rainfed. There is evidence everywhere that minor irrigation works such as stick dams, anicuts and tanks existed formerly in this Province, even though it is in the wet zone. Most of the anicuts are broken while many of the stick dams often collapse during floods and are rendered useless during the subsequent periods of dry weather. The bunds of the tanks have been breached and the tank beds have been *asweddumized* and are now cultivated with paddy. The owners of these fields resist any attempts to reclaim these tanks.

Perennial springs and streams, such as are used in the Central Province for irrigating paddy, are rare because of the absence of jungle-clad hills. The water level of most rivers and streams in the Western Province falls below the level of the fields during dry weather and consequently these streams cannot be used for irrigation without pumps or concrete anicuts.

Cultivation Seasons

The Province can be divided broadly into two zones—one zone north of the Kelani river where *maha* is the main season, and the other zone south of the Kelani where *yala* is the main season.

In the zone north of the Kelani river the *maha* crop is generally sown during the period late June to early September and is 4½-6 months in age. This sowing season is called *Harimaha*. Where 6 months varieties are sown for this season fields are generally fallowed for *yala*; where *yala* cultivation also is practised the *Harimaha* crop is of shorter duration (4½-5½ months) depending on the age of the *yala* crop. *Yala* sowing in this zone is done in March-April and the varieties sown are of 3-3¾ months duration. Where fields are fallowed for *yala* the tillage operations for the *maha* paddy crop are generally thorough, some good cultivators taking about 3 months over this work. During the fallow season cattle are grazed on the land and their droppings have a high manurial value. Where two crops are grown per year tillage operations are hurried and there is no opportunity for grazing cattle, but cultivators in these double-cropped tracts maintain that the annual production of paddy per acre per year is higher in double-cropped lands than in the lands which take one crop a year. What appears to limit *yala* cultivation in this zone is the availability of water for the *yala* crop. During *yala* seasons where the rainfall is abnormally high, there is invariably an increase in the extent which is cultivated for *yala* also.

The average yield in single-cropped fields is about 35 bushels per acre per year whereas in double-cropped tracts it is about 50 bushels per acre per year.

In the zone south of the Kelani river the main season is the *yala* when varieties from 5½ months to 4½ months are sown during the period late February to early April. Generally, varieties of 5 months duration are grown. The *yala* crop is followed by a

maha crop of 3½-4 months duration which is sown in October. This *maha* season is called the *maspassa* as opposed to the *harimaha*. As the interval between the two crops is short tillage operations are hurried—about 2 weeks elapsing between the first tillage operation and sowing. Yields in this zone are 25-30 bushels per acre per season for *yala*, and for *maha* 15-20 bushels per acre per season. It is significant that just thirty years ago the bulk of the paddy land in Salpiti Korale, Raigam Korale, Panadura Totamune and Kalutara Totamune was not cultivated for *maha* and was cultivated for *yala* only. Now most of the land is cultivated both in *maha* and in *yala*.

In tracts subject during the monsoons to heavy floods [especially floods from the Kelani river in Siyane Korale East (Gangaboda Pattu), Siyane Korale West (Adikari Pattu) and Hewagam Korale] an interseason crop called *muththes* is cultivated—sowing being done towards the end of December and harvesting at the end of March. The crop is a gamble as often it is damaged by drought, floods and pests.

Land Tenure

About 50 per cent. of the fields are worked by tenants on a share basis and the balance by owner-cultivators. Tenancy conditions are very variable. Generally, the landowner supplies manure and seed paddy, and the tenant then gets half the harvest after deducting the seed paddy and *huwandiram* tax, if any. If the tenant provides the seed paddy and manure he is entitled to two-thirds of the harvest after deducting *huwandiram*, if any. In some areas where the soil is very infertile the owner's share may be reduced to a quarter instead of half the crop. In some areas where the landowner supplies the draught animals, he takes one-eighth of the gross yield on this account before dividing the rest of the crop as land rent. Levying of *madaram* or ground rent is very rare.

Where the owner works the fields he employs hired labour to help him. Very few owners work their fields entirely by hired labour. Even paddy lands which form portions of big rubber and coconut estates are generally worked by tenant-cultivators on a share basis.

A survey made by the Revenue Staff of the Colombo District in 1953 gave the following data in respect of the Colombo District :—

Extent of paddy land	.. 61,400 acres (approx.)
No. of owners	.. 76,962
No. of owner-cultivators including cases where owner uses hired help	.. 46,642
Extent given out on *ande* basis ..	.. 28,000 acres (approx.)
No. of persons cultivating on *ande* basis	.. 33,986
No. of absentee owners	.. 13,542
Extent worked on other systems of tenure	.. 2,085 acres

The average extent worked by a tenant-cultivator for a season is about ¾-1 acre. The average size of paddy holdings is about ¾ acre ; but holdings vary from small fragments worked on a *tattumaru* system to about 50 acres owned by a few rich landlords and estates. But there is one person in the Colombo District who owns several hundred acres of paddy land scattered over a number of villages ; in this case no single compact block of paddy land belonging to him exceeds 10 acres in extent.

Irrigation Ordinance and Vel Vidanes

As irrigation facilities are few, *vel vidanes,* where they exist, have very little influence. In most areas the Irrigation Ordinance does not operate and, consequently, community works such as desilting of drainage channels and fencing have been neglected with consequent adverse effects on paddy cultivation. In the Kalutara District there are *vel vidanes* in every District Revenue Officer's Division and the total number of *vel vidanes* in the District is 207. They are not very popular as all they do is to collect their *huwandiram* share at harvest. There are a few *vel vidanes* in this District who do not attempt to collect *huwandiram.*

In the Colombo District no *vel vidanes* have been appointed in the Hewagam Korale, Salpiti Korale (except for one at Tumbowila), Colombo D. R. O's Division and Siyane Korale East, where there are in all about 30,000 acres of paddy land. In the rest of this District there are 212 *vel vidanes,* but they do not collect any *huwandiram* tax and they exist only nominally.

Progress of Improved Methods of Cultivation

Pureline Paddy. There appear to be about 40 different varieties of paddy grown in this Division—about 20 of which are grown in each season.

The only pureline which has appealed to the cultivators has been *Podiwi* a8 (6 months). This pureline, which can be grown only in the *maha* season provided sowing is done before September, can be grown on about 17,000 acres of land—most of which is situated north of the Kelani river. At present this pureline is grown on about 10,000 acres, though over much of this area the pureline has degenerated owing to unavailability of departmental stocks of pure seed in sufficient quantity to maintain purity over this large area. (This shortcoming has been rectified recently by the allocation of land at Polonnaruwa Paddy Station for the multiplication of this pureline.)

Ptb 16 was introduced in small quantities into Siyane Korale West (Adikari Pattu) in 1952, and into Hapitigam Korale in 1953. The trial plots did extremely well and impressed the cultivators. It is probable that this variety will replace *Podiwi* a8 in many areas as it has the advantage of being slightly shorter in duration than *Podiwi* a8.

Mas M.24 was introduced to the Province for the first time in *yala,* 1953, when it was grown on stations south of the Kelani river. There was nothing outstanding in these trial plots. It is being tried again in *maha,* 1954/55, in areas which require a 4½-5 months variety for *maha.*

Dewareddiri is popular in marshy areas subject to floods. It can be grown in *yala* only. It is not completely resistant to floods and tolerates only a certain degree of flooding. It can be grown in about 5,000 acres.

For the bulk of the paddy area in this Division at present, i.e., for about 70,000 acres in *maha* and about 60,000 acres in in *yala,* no suitable pureline selections have been evolved yet. *Murungakayan* 302 which is under trial in the paddy stations south of the Kelani river promises to be satisfactory where production of grain is concerned, but it has

been affected rather badly by diseases of the foliage. If *Mas* M.24 proves satisfactory it will serve a large area of the extent normally cultivated for *yala* south of the Kelani river.

Madael 137 has been recommended for *maha* and *yala* in Pasdun Korale East and Pasdun Korale West of the Kalutara District but cultivators have not been enthusiastic about it—especially for *maha*.

Many cultivators believe that the same variety should not be grown continuously and, therefore, they change varieties once in 3 or 4 years. Late rains often compel cultivators to grow varieties which are shorter in age than the varieties they normally grow. In areas subject to floods the harvest of paddy suitable for seed is very small; this is particularly so in the case of *Dewareddiri* which is recommended for marshy areas subject to floods. These factors impede the extension of pureline.

Manures. Bone manure has been the most popular manure for a long time. It has been applied in quantities varying from about 28 lb. to 1 cwt. per acre. As a source of phosphate it was well suited to the conditions prevailing in the Province as it was not washed away by floods or heavy rains and it is not immobilized by the high iron content of the soils. When applied in adequate quantities and in conjunction with organic manure it has given very good results.

With the rise in the price of bone manure and the evidence that potash was also required in these soils the Department has been popularizing the artificial fertilizer mixture recommended for the Low-country Wet Zone. This mixture contains :—

Sulphate of Ammonia ..	10	parts by weight
Concentrated superphosphate	5	do.
Saphosphosphate ..	8	do.
Muriate of potash ..	4	do.

The recommended rate of application of this mixture is 128 lb. per acre. Indications are that this mixture is best applied in 2 or 3 doses, and that if applied in one dose though early growth is very good there is little benefit at ear-head formation. The application of this fertilizer after the crop is 3-4 weeks old presents problems in places where heavy rains cause floods of even a day's duration. In many lowlying areas there is often a moving sheet of water for many days during periods of heavy rains in October and November, and this causes much loss of soluble fertilizers. Under such conditions bone manure in conjunction with organic manure and ash together with top dressings of small quantities of sulphate of ammonia and muriate of potash, when conditions permit, appear the best propositions. Organic manures such as green manure, leaf mould and compost are not being utilized sufficiently. Not more than 15,000 acres per year are manured adequately with organic manures.

Weeding. Weed growth is generally profuse because there is no control over irrigation water and the cultivation operations are generally hurried owing to double cropping. Weeds appear to be the biggest limiting factor to increased production of paddy. Not more than 20,000 acres are normally hand weeded annually at present.

Harrowing the Growing Crop. This operation is getting very popular as it is a cheap and easy way of destroying weeds with no risk to the crop (the operation being done only if conditions are suitable at the time). At present about 6,000 acres are harrowed in *maha* and about 5,000 acres in *yala.* The indications are that this operation increases yields by 6-7 bushels per acre on the average.

Transplanting. This operation has given varying results. In the tracts north of the Kelani river the response to transplanting in the long *maha* season has been satisfactory generally. A sample survery made by the Department of Census and Statistics in co-operation with the Department of Agriculture over nearly 3,000 acres transplanted north of the Kelani river in *maha* 1953-54 indicated that the yield increase in transplanted fields was about 12 bushels per acre, compared with adjacent broadcast fields. But even in this area a number of cultivators who have tried this operation once or twice have not persisted with it.

In the area south of the Kelani river in a large proportion of transplanted fields it has been found that there has been no significent yield increase compared to adjacent broadcast fields, even in cases where 5-5½ months varieties have been grown. Transplanting 3½-4 months varieties in *maha* has resulted in a depression of yields in a number of instances. Apart from the doubtful responses to transplanting this is an area where a large area of rubber is grown and therefore labour for paddy cultivation has been scarce and costly. A sample survery conducted in the Kalutara District in *yala* 1953 over 600 acres of transplanted fields entered for competitions, where intensive weeding and manuring were done in addition to transplanting, indicated that the yield in these transplanted competition plots was on the average about 17 bushels per acre higher than adjacent broadcast fields cultivated in the traditional manner. In these competition plots samples representing half the area transplanted in the Kalutara District showed, however, that the adjacent broadcast plots gave as much as the competition transplanted fields. In regard to the average yield increase of 17 bushels per acre in these transplanted fields it is not possible to state how much of the increase was due to weeding and manuring and how much was due to transplanting. Replicated experiments at Horana to compare transplanting with broadcasting have indicated no benefits by transplanting even of varieties 5-5½ months in age.

At present about 3,000 acres are transplanted in *maha* (mainly in the long *maha* tracts north of the Kelani river) and about 1,000 acres are transplanted in *yala* through the incentives of competitions in the area south of the Kelani river (mainly in the Kalutara District). Unless drainage and irrigation facilities are extended greatly it is not likely that more than 7,500 acres of the 150,000-160,000 acres cultivated annually in this Division could be transplanted satisfactorily. Of this transplantable extent the major portion is in the long *maha* tracts north of the Kelani river.

Use of Soil Inverting Light Iron Ploughs. These ploughs are used widely in tracts north of the Kenani river. Ploughing generally is restricted south

of the Kelani river owing to the scarcity of draught animals and the lack of pasture grounds.

Rotational Crops in Paddy Fields. Owing to bad drainage and the heavy rainfall the growing of rotational crops in paddy fields is generally impracticable. Rotational cultivation of short-term vegetables, such as *bandakka* and *me*, during February and April is done in selected *liyaddas* in about 100-200 acres of paddy land in the foothills of the Danowita-Madabawita area (32-34 mile-posts on Colombo-Kandy road). Even here if unseasonal rains are experienced many of these cultivators attempt a short-aged *yala* paddy crop in place of the vegetables.

Pests and Diseases of Paddy

Pests. Stem borers are the most troublesome pests—especially in the tracts north of the Kelani river. Broadcast as well as transplanted crops are affected by the pest, but it appears generally that the more luxuraint growth of the transplanted fields favours this pest more than does the broadcast crop.

Cultivations done too early or too late are generally badly effected by the paddy bug. The *mutnthes* crop is also generally affected badly by the paddy bug.

Occasionally thrips and leaf hoppers have proved troublesome on seedling paddy, especially during spells of drought which set in at the early stages of the paddy crop. These pests have been found to be unaffected by Gammexane but were controlled by the spraying of water dispersed D.D.T. Heavy rains also helped to control these pests.

Paddy swarming caterpillar has caused some sporadic damage occasionally.

Pests of stored grain (weevils and moths) caused much damage in this Province.

Diseases. Diseases of the foliage such as blast (*Piricularia oryzae*) and brown spot (*Helminthosporium oryzae*) appear to be spreading rapidly in this Province —especially in the area south of the Kelani river. Seed selection and seed disinfection need to be made routines to arrest the spread of these diseases.

Stem rots (Sclerotial diseases) occur occasionally. Owing to there being no control over irrigation and drainage in most areas and because fields may be sodden even at harvest there is little that can be done to control these diseases when they break out. Breeding disease-resistant purelines suitable for these areas coupled with potash manuring appear to be the most practicable solutions.

Suggestions for Increasing Yields

The most urgent need is to improve drainage and irrigation facilities. Unless these essentials are provided other improved techniques such as fertilizing, transplanting, weeding and harrowing the growing crop cannot be done satisfactorily. It is paradoxical that several thousands of acres are damaged by drought every year in some parts of the Province, while in the same season several thousands of acres are damaged by floods. Partial damage and loss of crop due to these factors must be very great. Below is an extract from the *Statistical Abstracts of Ceylon*, 1954, where figures for total crop failure due to floods and drought in the North-Central Province and the Western and Eastern Provinces respectively are compared. It will

be observed that damage by drought is as great in the Western Province as it is in the Eastern Province. In addition, there is the greater damage by floods in the Western Province.

Season	Province	Extent of Crop Failure: Due to Drought	Due to Floods	Total
Maha, 1949/50	W. P.	1,598	4,135	5,733
	N. C. P.	6,931	9	6,940
	E. P.	292	2,518	2,810
Yala, 1950	W. P.	2,076	2,926	5,002
	N. C. P.	3,774	38	3,812
	E. P.	263	267	530
Maha, 1950/51	W. P.	2,159	2,551	4,710
	N. C. P.	1,463	357	1,820
	E. P.	933	3,676	4,609
Yala, 1951	W. P.	492	3,346	3,838
	N. C. P.	1,936	347	2,283
	E. P.	190	86	276
Maha, 1951/52	W. P.	1,193	2,386	3,579
	N. C. P.	537	558	1,095
	E. P.	3,748	537	4,285
Yala, 1952	W. P.	954	2,183	3,137
	N. C. P.	1,390	68	1,458
	E. P.	1,784	—	1,784
Maha, 1952/53	W. P.	1,750	2,976	4,726
	N. C. P.	4,713	—	4,713
	E. P.	6,210	110	6,320
Yala, 1953	W. P.	2,240	1,123	3,363
	N. C. P.	3,985	—	3,985
	E. P.	345	1,205	1,550

Irrigation rules which provide for de-silting and maintenance of watercourses and for the cultivation of crops to time must be enforced. This is best done by means of officers paid by Government who have no obligations to the cultivators of the area. Government could obtain the necessary funds by the imposition of a land tax.

The breeding of disease-resistant high-yielding varieties suited to the climatic conditions is also an urgent necessity.

Animal Husbandry

According to the Census of 1946, the livestock population of the Province was as follows: Cattle 229,189, Buffaloes: 35,182, Goats: 35,897, Pigs: 30,081, Fowls 327,315, Ducks: 10,959, Turkeys:

3,501. Of the cattle and buffaloes about 25,000 are milch cows and about 4,000 milch buffaloes.

Cattle and Buffaloes. Dairying is concentrated in and around the towns. In Colombo, there are about 50 licensed dairies with a population of about 2,500 milch animals of which about half are Cape cows and the other half milch buffaloes (mainly Surati-Murrah crosses). The average production is about 10 lb. of milk per head per day. The size of herds belonging to individuals varies from about 5 animals to about 100 animals but the average herd consists of about 20-30 animals. There are about 100 cattle owners connected with these 50 licensed dairies—some dairy sheds being occupied by herds belonging to more than one cattle owner. These dairy owners generally take on lease swampy grass fields (mainly of water grass) within and on the outskirts of the city. Very few of them purchase grass. There is no systematic breeding of stock as the young stock and dry cows are generally sent to estates Up-country or sold to people engaged in the cattle trade. But owners of larger dairies have their own stud bulls and these are generally well proportioned Cape bulls, because these dairy owners believe that the milk production of the cows that are mated is improved if a good bull is used for the matings. The smaller dairies get their cows served by the stud animals of these larger dairies. In addition to these dairies, there are about 600 milch cows maintained by householders for their own requirements of milk. These too are mainly Cape cows. Generally, one such cow is kept by the householder but there are many cases where 2 cows are maintained in a household. These cows are sent to the nearest dairy stud to be served.

A large portion of Colombo's milk requirements is supplied by dairies within a radius of about 20 miles of Colombo. These dairies also maintain Cape cows and cross bred (European × Indian) cows chiefly. One or two of the progressive dairies are attempting to maintain purebred high-yielding cows of European breeds (Ayreshire, Friesians, &c.), but these animals require much attention and are very susceptible to tick fever ; further, the experience of some dairy owners is that this type of cow becomes sterile soon and needs to be sent Up-country after 2-3 years for rejuvenation. Though a few of these countryside dairy owners have been attempting some sort of stock improvement by breeding, the bulk of the country dairies follow the pattern of the town dairies in regard to dry animals and young stock.

There are about a dozen Co-operative Dairy Societies functioning in the Province. Most of these are within a radius of about 20 miles from Colombo. The largest is the society at Bomiriya which produces about 4,000 pints of milk daily, the bulk of which is sold in Colombo.

A Co-operative Milk Union with headquarters in Colombo has been established and the central pasteurizing and bottling plant of the Union in the Pettah is nearing completion. This Union is supplied by 17 societies most of which are in the Western Province. The total quantity of milk handled by the Union is about 7,000 pints per day at present. The pasteurizing and bottling plant can handle 20,000 pints per day but it appears that under present conditions the Union is finding difficulty in selling more than 7,000 pints daily in Colombo. A number of co-operative societies are being formed in the rural

areas to supply milk feeding centres with fresh milk.

There is, however, a very large population of Sinhala cows which are never milked. Judging from the census figures of the total cattle population in the Province the number of Sinhala breed cows which go unmilked must be at least 25,000. Even if a ready market is available for their milk it would probably be uneconomical to feed and milk these animals as dairy cows. Most of these cattle and buffaloes which are not looked after as milk animals or used for draught are grazed on estates for manurial purposes. Neat cattle as well as buffaloes are used for work in paddy fields.

Cattle improvement work done by the Department has been directed towards—

(i) Grading up of local cattle to selected Indian breeds (mainly Scindi) by making available the services of selected stud bulls and by sale of breeding stock. During the period 1947-53, 8,416 stud services were given and 319 heads of breeding stock were sold from farms in the Province to breeders.

(ii) Castration of scrub bulls to prevent indiscriminate breeding.

(iii) Introducing Friesian, Shorthorn and Ayreshire blood into dairy herds through the medium of artificial insemination. This service was started in September, 1952, and up to September, 1954, 682 artificial inseminations had been made.

(iv) Dissemination of advice regarding better feeding, the control of parasites and prevention of disease.

(v) Development of pure bred Scindi herds on Government farms for the sale of good breeding stock to breeders.

(vi) Attempts at acclimatization of highly-yielding European breeds such as Shorthorn and Friesians. These trials have not been concluded but the results so far are encouraging.

(vii) Dissemination of fodder and pasture-planting material.

Poultry. Poultry rearing is done on a fairly large scale in the coastal areas where non-buddhists predominate. There are no commercial flocks and most of the poultry rearing is in home gardens or back-yards. A large proportion of the birds now reared are cross-breds having a certain amount of Rhode Island Red, Australorp or White Leghorn blood in them. The rearing of pure breeds is becoming popular, especially in back-yards in towns. Experience on Government farms has shown that Australorps and White Leghorns are superior to Rhode Island Reds where egg laying is concerned. The Australorps have the advantage of being better table birds than White Leghorns. Australorps also feather early and are easier to rear than other breeds. During the period 1947-53, 147,759 setting eggs, 3,356 cockerels, 2,475 hens and 32,975 chicks, all of pure breeds (but mainly Australorps), were sold from Government farms to the public.

Poultry diseases continue to be a problem. As the flocks maintained by the average householder are small (5-10 birds) and scattered, the organization of routine preventive vaccination against such diseases as Pseudo Fowl Pest (Ranikhet) is difficult. However,

Top left.—A home garden in the Colombo District. *Top right.*—Pineapple interplanted with coconut at Gampaha. *Middle left.*—An average dairy in the Colombo area. *Middle right.*—An interior view of a dairy at Hulftsdorp. *Bottom left.*—A Cape stud bull in a dairy at Hulftsdorp. *Bottom right.*—A "Surati" buffalo in a Colombo dairy

from the beginning of 1949 to the end of June 1954, 291,051 vaccinations against Ranikhet disease have been given. Apart from Ranikhet, roup, fowl pox, worms and various digestive disturbances cause loss of production.

Other Livestock. Goats maintained are mainly the local nondescript type. They are hardy and can be reared without much difficulty. Pure breds, such as Jamnapari and Sainaans, have generally succumbed to paralysis or pneumonia under local conditions. The cross breds (with local blood) are better than the pure breds in this respect. Some breeders say that the Arakan is as hardy as the local type. Most of the goats reared are tether goats but there are a few grazing herds on some of the large coconut estates.

Pigs are reared mainly in the coastal areas by the christians. Most of the pigs are the local scavenging type. The rearing of pure breds is not economic at prevailing market prices for feed and pork. The experience of farms is that pigs (even pure breeds such as Berkshire and Large Blacks) do not grow so fast here as they do Up-country. Even with systematic feeding of concentrates a Berkshire does not reach more than 125 lb. in 6 months. However, a few influential pig breeders who have contracts with hotels, ship chandlers, &c., rear pure breeds on a commercial scale with good housing and feeding, but the basis of their feeding is cheap swill obtained from hotels and various other institutions, and they get a price higher than the general market price for their pork.

Government Farms

The Government farms in the Province are—(i) Government Farm, Walpita (327 acres), (ii) Government Farm, Horana (305 acres), (iii) Government Farm, Ambepussa (320 acres), (iv) Paddy Station, Bombuwela near Kalutara (10 acres), (v) Paddy Station, Panagoda near Homagama (27 A. 2 R. 15 P.), (vi) Animal Breeding Centre, Pasyala (26 acres), (vii) Animal Breeding Centre, Bandaragama (7½ acres).

A Girls' Farm School providing accommodation for about 85 girls is attached to the Government Farm, Walpita, while at Horana and Walpita Farms there are Boys' Practical Farm Schools with accommodation for about 25 students at each place.

The Monsoons and their Influence on the Ceylon Weather

G. S. JAYAMAHA

Wind Circulation over Ceylon

THE general movement of the air over Ceylon is determined chiefly by the general temperature and pressure conditions in the larger area of the meteorological region of which the Island forms a part. This general movement is somewhat modified by the local temperature and pressure conditions and by the geography of the Island. The general conditions determine the two great movements—the southwest and northeast monsoons.

Circulation in the Tropics and Subtropics

The surface of the earth is not heated uniformly by radiation received from the sun. The intensity of heat received by any particular region will depend on the position of the region relative to the sun. (The amount of heat absorbed will also depend on the condition of the atmosphere and the nature of the ground surface). Naturally, that region which is vertically below the sun will receive maximum heat energy from it because the incidence of solar radiation will be normal to the surface of the earth in the locality. Thus, during any particular month or season of the year, there will be a belt round the earth's surface (practically parallel to the geographical equator) where the temperature is higher than in the areas to its north or south. This belt is generally known as the thermal equator. The thermal equator moves northwards or southwards along with the relative movement of the sun.

Due to the differential heating between the thermal equator and the areas immediately north and south of it, the air at the surface of the thermal equator becomes less dense and, consequently, ascends. This air is immediately replaced at the surface by air from the regions immediately north and south of it. The ascending current reaches a height of several thousand feet above the surface, the actual height depending on the nature of the surface. When this ascending current reaches the upper limit it breaks up into two streams, one moving in the northern hemisphere and towards the north pole and the other moving in the southern hemisphere and towards the south pole. These streams are influenced by the deflective effect of the earth's rotation. This influence causes an air current in the northern hemisphere to be deflected towards its right while a current in the southern hemisphere is made to turn towards its left. The air stream in the northern hemisphere will, therefore, assume a southwesterly direction while the other will have a northwesterly direction. Each of these streams will be gradually cooled because it is moving towards colder regions. Hence the air becomes more and more dense until, at about 30° latitude, it begins to descend. This causes a heaping up of air and gives rise to a region of general high pressure. Air will quickly move out of this high pressure area on account of the tendency of nature to equalize. The major portion of this air travels towards

the thermal equator and completes the closed link of the general circulation of the region. The other portion of this air continues its journey towards the pole. The returning current will have a northeasterly direction (due to the deflective effect) in the northern hemisphere and a southeasterly direction in the other hemisphere. These return currents are known as the **trade winds** while the upper air streams are called the **anti-trades.** (See Fig. I.).

Air Masses and their Boundaries

From the preceding discussion it is clear that there are two distinct air masses (each with an eitirely different history) within the region of this circulation. One is the northeast trade of the northern hemisphere and the other is the southeast trade of the southern hemisphere.

Consider, for instance, a season when the thermal equator is situated in the northern hemisphere. When the south-

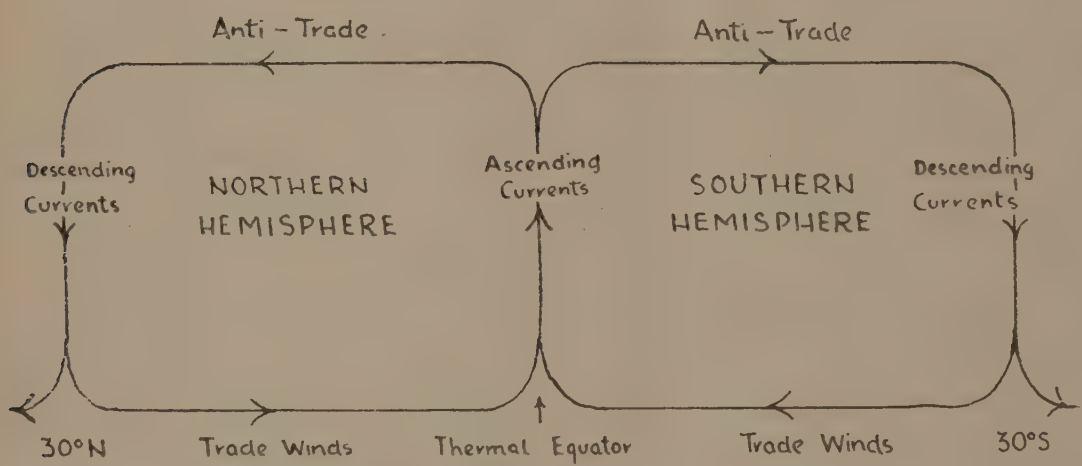


FIG. I.—A vertical section showing the general circulation of the winds in the tropics and sub-tropics.

east trades move beyond the geographical equator, their direction alters on account of the change in the deflective effect of the earth's rotation, and the winds appear as a southwesterly current. These deflected trade winds are known as **monsoon winds.** Due to the difference in direction of the air movements on the two sides of this junction the wind streams converge and the air is forced to ascend. Pressure decreases with increase of height in the atmosphere. Hence the ascent of air is associated with lowering of pressure and, therefore, expansion. This expansion causes cooling (adiabatically) of the air provided no heat is communicated to the ascending air. If ascent and cooling continue the air may reach its dew point and any further cooling will cause water droplets or clouds to form. With continued ascent the droplets will keep on growing and increasing in weight until they become too heavy to be held within the cloud. They will then descend in the form of rain. This shows that, under suitable conditions, convergence of wind streams leads to the formation of cloud and rain.

Figure II is a horizontal section of the wind streams. The deflected trades or monsoon winds are generally known as the **equatorial westerlies.** From the diagram it is clear that the equatorial westerlies converge with the northeast trades along their boundary. This, too, usually produces cloud and precipitation. The two boundaries or zones of convergence are usually known as the northern and southern convergence zones.

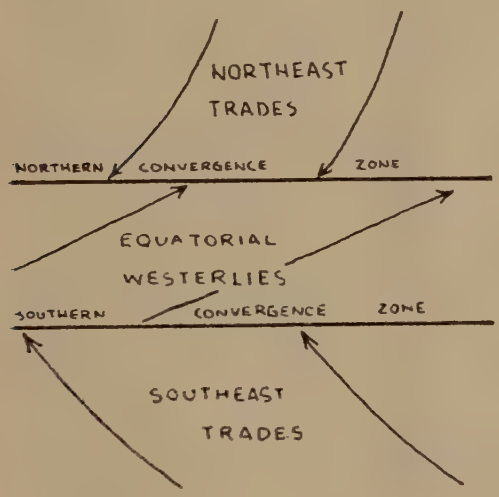


FIG. II.—A horizontal section showing the air streams and their boundaries, with the S. E. Trades bending near the geographical equator.

When the thermal equator is in the southern hemisphere, the geographical equator is the junction between the northeast trades and the equatorial westerlies while (approximately) the thermal equator forms the boundary between the southeast trades and the equatorial westerlies.

One or the other of these two zones moves north or south with the relative movement of the sun with a lag of about two months. The other remains practically stationary near the geographical equator. The moving zone is always found in the summer hemisphere and is usually referred to as the Intertropical Front.

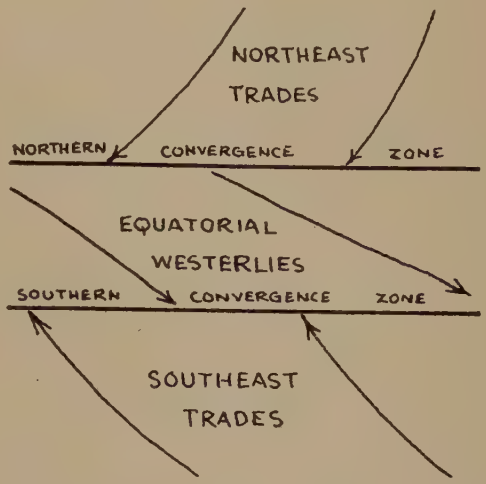


FIG. III.—The bending of the N. E. Trades near the geographica equator.

The northern convergence zone crosses Ceylon through the lowest layers of the atmosphere during April on its northward journey and during October on its return. On the other hand, the southern zone has not been known to lie over Ceylon. Perhaps, it never reaches the Island.

When the northern convergence zone moves away to the north of Ceylon the Island comes under the influence of the equatorial westerlies or the southwest monsoon stream. Monsoon activity, however, is not experienced over the Island until the latter half of May because an air stream of sufficient depth is required for such activity. The onset of the monsoon is generally associated with heavy rain, particularly if the convergence zone is associated with a centre of low pressure.

This air stream has a very high moisture content owing to the fact that

it has reached the Island after a long journey over a warm sea. As a result this air stream is a potential rain-bearer and lifting of this air when it strikes a coastline or a range of hills causes the building up of large cumulus and cumulonimbus clouds and, in certain cases, the production of rain. Orographic features are, therefore, of great significance in the distribution of the monsoon rainfall. Precipitation over the Island is induced by the south and west coasts and the central hills, and the rainfall due to the southwest monsoon is practically confined to the southwest quarter of the Island and the western and southern slopes of the exposed hills. Most of the monsoon rain falls from isolated cumulonimbus clouds. The rainfall is neither continuous nor uniform because it depends on the strength of the wind stream. The wind strength varies considerably and appears as a series of pulses.

The average total rainfall during the monsoon season is highest in the Watawala area where the total generally exceeds 120 inches for the period of five months from May to September. The average totals decrease steadily towards the southwest coast. The average values along the coastal belt are less than 60 inches, being 40 to 60 inches between Ratmalana and Weligama, 20 to 40 inches from Dehiwala to Horakele and from Matara to Tangalla, and below 20 inches from Chilaw onwards along the west coast and beyond Tangalla along the south coast.

As mentioned earlier the northern convergence zone generally crosses the Island in October during its southward journey. In other words, the southwest monsoon withdraws from the Ceylon area at the end of September or during the early part of October. This retreat of the monsoon is usually accompanied by fairly general rain over most parts of the Island.

The northern convergence zone moves over successive regions of the Indian sub-continent, during its northward journey, after it passes Ceylon. This results in the southwest monsoon air stream reaching India only after the monsoon conditions are well established over the Island, the onset of the monsoon being experienced in the southern and central portions earlier than in the north. Southwest monsoon conditions are finally established over Pakistan and northern India during July. With the return of the convergence zone towards the equator this monsoon stream commences its withdrawal from the northern-most regions during the latter part of August. The retreat of this monsoon from the central and most of the southern areas of India takes place during September.

The Northeast Monsoon

Ceylon comes under the influence of the northern hemisphere trade winds when the northern convergence zone is to the south of the Island. This generally occurs from the beginning of December to the end of February. During this period the northeast monsoon prevails over the Island.

Orographic lifting of this air by the east coast and the northern and eastern slopes of the central hills gives rise to rain in the north and east, particularly along the windward slopes of the hills. The highest rainfall in this locality during the northeast monsoon is experienced in the Nitre Cave area where the average total for the three months is between 80 and 90 inches.

The Madulsima, Gammaduwa and Urugala areas come next with totals ranging from 50 to 70 inches for the period. Along the coast the greatest rainfall is experienced in the Valaichenai, Batticaloa, Kalmunai and Akkaraipattu areas with average totals of 30 to 35 inches. South of Akkaraipattu the season's rainfall decreases gradually towards Pottuvil and Panawa where the averages are between 25 and 30 inches. Beyond Panawa the decrease is more abrupt, the total rainfall in Yala being only about 15 inches. North of Valaichenai, too, there is a decrease in the northeast monsoon rain along the coast. The approximate average totals at Trincomalee, Mullaittivu and Point Pedro are 25, 20 and 15 inches, respectively.

It is obvious from what has been stated earlier that the northeast monsoon establishes itself over the northern and central regions of the Indian subcontinent long before it reaches Ceylon. It is also clear that the withdrawal of this monsoon from the Island commences earlier than from the subcontinent, the monsoon withdrawing from Pakistan and Northern India only after it has retreated from the southern and central areas.

Transition Periods

The periods, March-April and October-November, are neither in the southwest monsoon season nor in the northeast monsoon. During these months the northern convergence zone lies either across Ceylon or in its immediate vicinity and the air stream over the Island does not consist purely of one type—the northern trades or the equatorial westerlies.

Summary

Southwest monsoon conditions prevail over the Island from May to September and northeast monsoon conditions from December to February, the technical criterion being the position of the northern convergence zone. The rainfall of the southwest monsoon is practically confined to the southwest quarter of the Island, the heavier falls being concentrated along the southern and western slopes of the hills. Northeast monsoon rain is experienced chiefly in the north and east with the larger falls along the northern and eastern slopes of the central hills.

Flowering and Fruiting Habits of the Mango in the Wet Zone

E. P. BUELL

Introduction

THE quality of indigenous varieties of mango grown in the wet zone is depressingly poor.

The testing of numerous introductions from India, Africa and Mauritius was accordingly commenced at the Experiment Station, Peradeniya, in 1938. The varieties included the Western-Indian *Alphonse, Pairi, Cowasji Patel, Sufeida, Batli* and *Langra,* the South-Indian varieties *Neelam, Chinnaswarnareka,* Bangalora and also the African varieties Sabre and *Gundoo.* In addition to these, the famed Jaffna varieties *Karuthakolumban, Vellaikolumban, Ambalavi* and Willard were also introduced. Local varieties and an Indian variety *Peterpassand,* which had been previously grown at the Experiment Station, Peradeniya, were budded and planted out at the same time. Some of the varieties were monoembryonic and others exhibited varying degrees of polyembryony. The seed of a polyembryonic variety produces several seedlings all of which except one sexual seedling are of nucellar origin. This sexual seedling is often the weakest and usually dies early. But the monoembryonic seed produces only a sexual seedling which is quite vigorous. A monoembryonic variety may become polyembryonic with change in environment. It is claimed, the *Alphonse,* a monoembryonic variety of Western-India, developed polyembryony in Queensland in four generations. The distinctly polyembryonic varieties in the present study were the indigenous *Kohuamba, Vellaikolumban* of Jaffna and the Sabre of Africa. All other varieties were monoembryonic, with the exception of the *Gira-amba, Neelam, Karuthakolumban, Sufeida, Tatapari* and *Peterpassand* in which the expression of polyembryony varied. The *Gira-amba* showed polyembryony to an extent of over 80 per cent.; in *Neelam* it was 2 per cent. The varieties were assigned on the basis of the shape, size and quality of fruits, to the four groups, *Mulgoba, Alphonse, Sandershah* and *Cambodiana.*

Growth Habit

The production of leaf 'flushes' in mango shows marked periodicity. A period of active growth is followed by a cessation of growth. The number of flushes per year varies with variety, and is influenced in the wet zone by the distribution of rainfall. Normally in the dry zone and in Jaffna, only one or rarely two periods of active growth are observed during the year, on account of the seasonal rains. In the wet zone, however, the number of flushes varies in the different varieties from 2-6 per year—a feature which is related to the irregular fruiting habit in this zone. In certain varieties like the *Batli* and *Langra,* the whole tree or almost every branch produces a new flush, but in

Adapted from a paper read at the ninth session of the Ceylon Association for the Advancement of Science

certain other varieties such as *Neelam* and *Peterpassand*, the new flush is confined to a few branches, and in rare cases as in *Chinnaswarnareka* to a section of the tree. Inflorescence initiation occurs when a vegetative flush has attained maturity—a process that takes 4-5 months. If differentiation does not take place, the bud continues its vegetative growth and the subsequent inflorescence initiation depends on the prevailing nutritional balance and on the climatic conditions. A partial differentiation occurs in rare cases as in the variety *Peterpassand* where mixed inflorescences are sometimes found. The season of flowering in the wet zone is December-January. Some varieties such as the *Chinnaswarnareka* flower as early as October-November, while *Tatapari* and *Peterpassand* flower as late as February-March.

Onset of Flowering

Nutritional factors that inhibit the flowering of mangoes in the wet zone include (i) a low carbohydrate content during the period when inflorescence initiation is due, (ii) excess of nitrogen in the presence of adequate soil moisture. The treatments investigated attempt either a reduction in the up-take of nitrogen by the tree, or an increase in the carbohydrate content of the fruiting spurs.

Summary of Treatments

Treatment I. Ringing or girdling of the main branches was done to remove the phloem tissue and thus interrupt the translocation of carbohydrate from the branches to the other parts of the tree. The ring was cut in the form of a complete spiral ½ in. wide so that water might drain off and not cause decay.

Treatment II. Root pruning to retard the up-take of nutrients temporarily and increase the concentration of carbohydrates in the branches was found impracticable. Trees were unearthed and fibrous roots pruned, but rain water accumulated in the pit.

Treatment III. Light pruning of the apical ends of branches and thinning of dense branches were carried out in October in order to promote photosynthesis and to increase the carbohydrate content.

Treatment IV. The new flush of leaves occurring during the month of October at the apical ends of branches was removed with the object of increasing the concentration of carbohydrates in the preceding flush.

Treatment V. The effect of smudging or of a smouldering fire under the drip of the crown during the pre-flowering period was tested.

Treatment VI. Phosphate and potash were supplied in a fertilizer mixture containing 4 parts of concentrated superphosphate and 1½ parts of sulphate of potash ; 12 lb. were applied per tree. The mixture was deposited in holes 2 ft. deep and 1 ft. apart at the rate of 2 oz. per hole.

Treatment VII. The effect of common salt at the rate of 10 lb. per tree was tested.

Summary of Results

Treatment I induced flowering in all the varieties but the number of panicles

produced varied with the variety. The *Alphonse* produced an average of 12 panicles, the *Karuthakolumban* 110 panicles, *Neelam* 148 panicles and the *Peterpassand* 270 panicles.

Treatment III depressed growth initially, but produced in the instance of all varieties a complete new flush of leaves with the heavy rains. None of the varieties flowered.

Treatment IV: All the varieties flowered. The *Alphonse* produced an average of 36 panicles over six seasons, *Karuthakolumban* 240, *Neelam* 280 and *Peterpassand* 320. In *Karuthakolumban* a few panicles appeared on the trunk, and in the *Neelam* several on the lateral branches. The distal axillary buds differentiated into flowers but the panicles were more (1-3 in each branch), and were smaller in size than the normal terminal ones.

Treatment V: The *Alphonse* gave an average of 15 panicles, the *Karuthakolumban* 28, *Neelam* 82 and *Peterpassand* 34 panicles. Rain interfered with the treatment. It was not possible to maintain a steady fire throughout, and the duration of the treatment was limited to 20 days during the month of October. The nature of the treatment effect is obscure.

Treatment VI: Only one variety, viz., Willard, responded to this treatment, during the 'on' season, but in other varieties the effect of the fertilizer was seen in the subsequent season. Willard is a dwarf variety with a shallow root system and the up-take of the fertilizer was probably rapid. Willard produced 12 panicles during the first "on" season after the application of the fertilizer. During the next season others flowered; *Alphonse* produced 6 panicles, *Karuthakolumban* 80, *Neelam* 20 and *Peterpassand* 110, and Willard 4 panicles.

Treatment VII: None of the varieties flowered.

Fruit Set

Flowering does not necessarily result in fruit set. The panicle consists of perfect and male flowers. Perfect flowers are generally few in number, but vary widely with variety. In the *Alphonse* the number of perfect flowers is about 5 per cent., but in the *Peterpassand* the number is as high as 50-60 per cent. All perfect flowers, however, do not set fruit. In the *Alphonse* variety, although the panicle consists of 500-600 flowers, only about 3 or 4 set fruit. The failure to set fruit may be due to paucity or low viability of pollen grains or to climatic factors affecting pollination. The single stamen in certain varieties like the *Alphonse* contains little pollen. In *Neelam*, under humid conditions pollen loses viability and shows poor germination. In rare cases, as in *Chinnaswarnareka*, self-incompatibility has been observed. *Chinnaswarnareka* is the earliest to flower, but during the six experimental seasons only three flowers set fruit. Rain at the time of anther dehiscence washes away the pollen and prevents pollination. The effects of climatic factors on fruit set vary with the flowering habit of the variety. Early flowering varieties produced the lowest fruit set owing to rains, and the late varieties the highest. Climatic factors apart, fruit set was determined by the ratio of perfect to male flowers.

Irregularity in Fruiting

Unfruitfulness in the wet zone is often due to an irregular bearing habit. *Karuthakolumban* and *Neelam*, for instance, fruit heavily in one season, but produce little or no fruit in the subsequent season. It is not uncommon for only a part of the tree to bear in this manner. Even branches of the same tree have been observed to bear in alternate seasons. This alternate bearing is due to the exhaustion caused by a heavy crop during the 'on' season. The depleted nutrients are not adequately restored for the next season's flowering and the tree therefore skips one season. Prolific varieties are more inclined to this habit. It is possible to predict in these varieties the season of fruitfulness unless it is affected by climate, pest or disease factors. Treatments designed to restore rapidly the nutrient level were investigated. A light pruning during the 'on' season and a hard pruning during the 'off' season reduced the fruiting branches and raised the carbohydrate content. The carbohydrate-nitrogen ratio soon reached the threshold value necessary for fruit bud formation. Growth has to be stimulated before it can be controlled by pruning. If growth is not induced soon after harvest in July, an October flush normally occurs in the wet zone, this is rarely the fruiting spur for the next 'on' season. The July-August flush, however, is generally the fruiting 'spur' as the longer interval permits the accumulation of carbohydrate and the initiation of the flower buds. An early flush was therefore induced by the application of sodium nitrate. An application of 6 lb. per tree during wet weather brought the new flush on within 15-20 days in the variety *Neelam*, and in about a month in *Karuthakolumban*. Deblossoming and fruit thinning was given to some trees to reduce the crop during the 'on' season, but was found ineffective in all varieties treated. Only two varieties, namely *Peterpassand* and Sabre fruited consistently over the six experimental seasons. *Peterpassand* surpassed Sabre both in yield and quality of fruit, and has been the variety that performed satisfactorily in the wet zone.

The carbohydrate-nitrogen ratio is not the only factor limiting the production of mangoes in the wet zone. Satisfactory control of growth is necessary for the establishment of a fruiting spur. Varieties with a greater proportion of perfect flowers set fruit better. Consistent bearers are rare in mango. Treatments designed to induce flowering are uneconomic in commercial cultivation though it may be the only remedy in certain varieties like the Western-Indian *Alphonse*. The untreated controls in these varieties have not so far produced even a single panicle. Sabre and *Peterpassand* flowered freely and were unaffected by treatment. A wider range of introductions must be tested if further advances in selection are to be achieved for the wet zone.

Conclusions

The results presented above permit the following tentative conclusions :—

(i) Polyembryonic varieties are more fruitful in the wet zone.

(ii) Fruit production in a variety is inversely correlated with flush number per year.

(iii) Flowering on *Kohu-amba* root stock is more profuse than on *Wal-amba.*

(iv) The *Cambodiana* and the *Sandershah* groups flower and fruit best.

(v) Late varieties that flower in February-March are the most suitable for the wet zone.

(vi) Varieties with a 'whole tree flush' are the most fruitful, but show a tendency to biennial bearing.

Acknowledgment

I am grateful to Dr. M. F. Chandraratna for valuable suggestions and useful criticism.

Reference

BUELL E. P. (1951). A variety of Mango for the low and and mid wet zones—*Tropical Agriculturist—Vol.* CVII, p. 184.

The Cultivation, Curing and Processing of Bidi Tobacco

S. V. MANUEL PILLAI

Introduction

THE original home of tobacco is South America. The cultivation of this crop was extended to other places by the Spaniards and the Portuguese about the fifteenth century. It is now grown in over a hundred countries. Although there are 50 species of tobacco, only two of them *Nicotiana tabacum* (Bidi tobacco) and *Nicotiana rustica* are grown for smoking purposes in the form of cigar, cigarette or bidi. Certain other species are used for ornamental or medicinal purposes. The alkaloid, nicotine, found in tobacco has a stimulating effect on the human body. Nicotine is an oily colourless liquid, soluble in water, fairly volatile and with a characteristic, strong odour. The nicotine content of cured tobacco varies from .01-6 per cent.

India is the main bidi tobacco growing country producing about 120 million pounds per year. In Ceylon the cultivation of bidi tobacco has so far not been undertaken on any appreciable scale. Small areas are cultivated during the *maha* season in the Kurunegala and Polonnaruwa Districts. It is possible to extend the cultivation of this crop to other areas in Ceylon such as Matale North, Ridiyagama and the Jaffna Peninsula. Considering the fact that the imports into Ceylon in 1953 were 1,959,730 lb. of manufactured bidis valued at 8,610,708 rupees and 120,875 lb. of unmanufactured bidi tobacco valued at 282,267 rupees, the possibilities of extending the cultivation of this crop should receive serious consideration. The average yield of cured tobacco is 500 lb. per acre. On this basis it should be possible to make the Island self-sufficient in this commodity, if a further 1,500 acres could be brought under this crop in addition to the 50 acres already under cultivation.

Nursery Technique

For the successful production of a good crop of bidi tobacco special attention should be paid to the preparation of the nursery. The nursery area should be well drained and situated close to a permanent source of water, as this will reduce the cost of raising the seedlings. The nursery site should be changed every year to reduce the incidence of pests and diseases. The nursery area should be cleared and ploughed about a month before actual nursery operations commence. Thereafter, about 20 tons of cattle manure or compost per acre should be spread over the area evenly and turned in.

The site should then be levelled and lined off for raised beds four feet wide with three feet broad drains separating them. Each bed should be worked to a fine tilth, properly levelled, and sterilized by the open-fire method. A fertilizer mixture (consisting of 2 lb. of sulphate of ammonia, 1 lb. of sulphate of potash and 1 lb. of superphosphate) should be applied at the

rate of 6 lb. per bed of 200 sq. ft. About two spoonfulls of seed in 200 sq. ft. of nursery will give sufficient seedlings to plant an acre. Sowing must be done evenly and the soil compacted gently. Hand watering should be done judiciously to keep the beds moist but not too wet. Only healthy seedlings should be transplanted.

Climate and Soil

Bidi tobacco requires a cool moist climate with light rainfall during the growing period. Low temperatures prevalent in January and February in the dry zone are favourable for the development of good quality leaves. The harvesting period must be dry to facilitate curing, which is done in the open fields. This crop can be grown from sea level up to 2,000 feet. Bidi tobacco can be grown on a wide range of soils varying from heavy loam to sandy loam, provided drainage is good, as the plant cannot stand water-logging conditions.

Preparation of Land and Planting

The land for planting should be ploughed, harrowed, levelled and kept free of weeds. About 5 tons of cattle manure or compost should be applied at the time of preparation. As bidi tobacco responds well to heavy nitrogenous manuring, green manuring with Sunnhemp or the application of 2 cwt. of sulphate of ammonia in split doses is recommended. The land can be marked for planting with a bullock-drawn marker. The distance of planting is 3 × 3 or 3 × 2 feet depending on soil fertility. A wider spacing favours the production of leaves of better quality.

Varieties K 49 and G 6 are suitable for areas under irrigation; S 20 and S 12 are preferable for rain-fed areas.

After-care of Crop

After planting, the crop should be shaded and hand watered if necessary. Vacancies should be filled within a fortnight. The priming of sand leaves should be done from about three weeks after planting. Regular intercultivation is necessary to keep the land free of weeds.

Topping is done when the plant has developed 10-12 good leaves, i.e., about 40 days after the date of planting. Low topping is done early to encourage the development of heavy textured leaves. Four-five suckerings are done at weekly intervals till the plants are fully developed as indicated by the leaves puckering and turning slightly yellow. The formation of Spangles (reddish-brown spots) on mature leaves is taken as a criterion of good quality. Unlike in cigarette tobacco the top leaves mature first.

Harvesting and Curing

Harvesting is done in the morning by cutting the plants about 2 inches above ground level. The plants are then turned upside down so that the tops rest on the ground. They are left in this position to dry for 6-8 days. As all plants do not mature at the same time, a field should be harvested two or three times at weekly intervals to obtain good quality cured product.

In bright weather the *laminae* dry in three to four days. When dry the *laminae* are stripped of their midribs in the morning, transported to the

store and bulked in loose heaps. The midribs are further allowed to dry in the field for about a fortnight, and when completely dry are separated from the stem of the plant and stored in loose bulks. In the process of curing the green leaves turn from yellow to light-brown in colour. The colour preferred in the market is greenish-yellow with reddish-brown spots. Top leaves are superior in quality. One of the essential features in successful bidi tobacco cultivation is the absence of rain during curing. Quick curing in bright sunshine produces leaf with the desired colour. The cultivation of bidi tobacco does not incur large sums of money for the erection of curing barns and handling sheds as is the case with cigarette, cigar and chewing tobacco varieties.

Grading

Though there are no well defined grades in the market, the following points are taken into consideration in assessing the value of cured product. The colour should be greenish-yellow with brown spots. The leaves should burn well with a strong pleasant smoke. The texture should be thick but not very coarse, so that the leaf may not crumble into dust when slightly pressed in the palm of the hand. As the top leaves are superior in quality, they can be cured and marketed separately. The yield of cured tobacco varies from 500 lb. under rain-fed conditions to 900 lb. under irrigated conditions.

Processing of the cured leaves for manufacturing bidis consists mainly of crushing the leaf into small flakes and sieving them. The sieved portions are graded according to their relative sizes. The leaf is ready for bidi manufacture after about two months of curing.

Bidi Manufacture

Bidi is prepared by rolling about half a gramme of tobacco flakes, which vary in size from 1/70th to 1/90th of a square inch, in the bidi wrapper leaf. Bidis vary in length from two to three inches. Quality depends on colour, strength, thickness, granulation of the leaf, degree of spangling and smoking quality. At times, leaves of *Nicotiana rustica* are used for mixing with bidi tobacco leaves for manufacturing bidis. About 3/4 to 1 lb. of tobacco and 2 lb. of wrapper leaves are required to make 1,000 bidis, depending on size. 250 wrapper leaves weigh about a pound.

Bidi tobacco has 4-5 per cent. of nicotine. Bidi, after it is rolled, is heated for 5 minutes and then dried for 12-24 hours before packing. Bidi can be stored for 4 months without loss of quality.

The wrapper leaves are moistened the previous evening and the next morning the leaves are cut into rectangular pieces. One leaf will give 2 to 4 pieces. The colour of the wrapper leaf is important in marketing the manufactured product. A greenish-white colour is best. The wrapper leaf must have good flavour, flexibility, resistance to early decay and must burn well. Leaves of the following trees are used as wrappers :—*Diospyres melanoylon, Bauhinia racemosa, Castanopsis indica, Butea frondosa, Careya arborea, Shorea robusta.* Of these,

Diospyres melanoylon is abundant in the jungles of Ekiriyankumbura, near Bibile, in the Province of Uva.

General

Results of experiments at the Anand Bidi Tobacco Research Station indicate that—(1) The produce from higher nitrogen treatments are valued more (up to a limit of 160 lb. of nitrogen per acre in the form of oil cakes) than the produce from treatments with low nitrogen levels, (2) The nicotine content increases with increase in nitrogen up to 80 lb. per acre, after which it remains almost constant.

BIDI TOBACCO CULTIVATION IN INDIA (BOMBAY STATE)

Cost of Cultivation per Acre	*Rs. c.*
Preparatory cultivation	49 0
Manure and manuring	74 0
Seed and sowing	14 0
After tillage	84 0
Harvesting and preparation for market	13 0
Total	234 0

Income per Acre	*Rs. c.*
740 lb. of cured leaf sold for	836 0
Nett profit	602 0

Reference

Anand Bidi Tobacco Research Station Annual Report 1952-53.

Brief Notes on some Wild Flowers of Ceylon

J. E. SENARATNA

THIS article and accompanying plate are the outcome of a request by Dr. A. W. R. Joachim, Director of Agriculture, to the writer to prepare a poster of the Wild Flowers of Ceylon.

Thirty-one of the more familiar and arresting flowers representative of our flora are illustrated and a brief note on each is given. The painting was done by Mr. H. M. Fonseka of the Department of Agriculture and the reproduction here shows the flowers at half their linear size. The plants are arranged below according to the system followed in *Trimen's Flora of Ceylon*, to which the reader is referred for a fuller description.

1. Nymphaea stellata *Willd.* (Nymphaeaceae) ; Manel (*Sinh.*) ; Blue Lotus. A water-lily with floating leaves and flowers rising above the water ; flower pale blue to violet, sweet-scented, throughout the year ; in tanks, and ponds in the low-country, rather rare.

2. Nelumbium nelumbo (*L.*) *Druce* (Nymphaeaceae) ; Nelum (*Sinh.*) ; Tamarai (*Tamil*) ; Lotus. A large water-lily with leaves and flower raised much above the water ; flower white or rose-coloured, sweet-scented, from February to August ; in still water, especially tanks, in the low-country, common in the dry districts.

3. Mesua ferrea *L.* (Guttiferae) ; Na (*Sinh.*) ; Naka (*Tamil*) ; Ironwood. A moderate-sized tree with blood-red young leaves changing to green ; flower white with yellow stamens, sweet-scented, from April to June ; common in forests of low-country, especially in the moist region.

4. Hibiscus collinus *Roxb.* (Malvaceae) ; Wild Shoeflower. A slender shrub ; flower pale pink or white, with deep red-purple centre, from January to February ; common in forests and jungles in the low-country.

5. Crotalaria laburnifolia *L.* (Leguminosae : Papilionatae) ; Yakberiya (*Sinh.*) ; Stalked Rattle-pod. A slender plant 2 to 5 feet high ; flower bright pale yellow, from February to May ; common in scrub in the low-country and extending to the mid-country.

6. Erythrina variegata *L.* (Leguminosae : Papilionatae) ; Eramudu (*Sinh.*) ; Mullu-murukku (*Tamil*) ; Coral Tree. A slender prickly tree, leafless at flowering ; flower scarlet, from February to March ; very common and much planted for fences in the low-country.

7. Cassia fistula *L.* (Leguminosae : Caesalpinioideae) ; Ehela (*Sinh.*) ; Tirukkontai, Kavani (*Tamil*) ; Ceylon Laburnum. A small tree ; flower bright pale yellow, from July to August ; very common in forests of the dry region ; conspicuous whether covered with its drooping clusters of flowers or its pendulous black cylindric pods.

8. Cassia auriculata *L.* (Leguminosae : Caesalpinioideae) ; Ranavara (*Sinh.*) ; Avaram (*Tamil*) ; Tanners'

Cassia. A bush with bright yellow flowers from February to March ; common in the low-country, especially in the dry areas near the coast.

9. Barringtonia acutangula (*L.*) *Gaertn.* (Myrtaceae) ; Ela-midella (*Sinh.*) ; Adampu (*Tamil*). A small tree with hanging clusters of cream flowers with conspicuous bright crimson stamens, from June to August, round margins of tanks in the dry region.

10. Osbeckia octandra *DC.* (Melastomaceae). A small shrub ; flower reddish-purple, often pale, throughout the year ; common in moist situations in the low-country and extending up to 5,000 feet elevation.

11. Memecylon umbellatum *Burm.f.* (Melastomaceae) ; Kora-kaha (*Sinh.*) ; Pandikkaya (*Tamil*). A large bush ; flower brilliant dark blue, from March to September ; common in low-country jungles.

12. Lagerstroemia speciosa *Pers.* (Lythraceae) ; Muruta (*Sinh.*) ; Pumaruthu (*Tamil*) ; Pride-of-India. A large tree ; flower deep or pale mauve or bright rose-coloured, from April to July ; rather common in wet places in the moist low-country and mid-country.

13. Ixora coccinea *L.* (Rubiaceae) ; Ratambala (*Sinh.*) ; Vedchi (*Tamil*) ; Scarlet Ixora. A shrub ; flower brilliant scarlet, throughout the year ; common in moist places in the low-country and mid-country.

14. Rhododendron arboreum *Sm.* (Ericaceae) ; Ma-ratmal, (Asoka) (*Sinh.*) ; Rhododendron. A small stout twisted tree ; flower dark crimson, from April to July ; rather common in open ground in the upper montane zone above 5,000 feet.

15. Wrightia zeylanica *Br.* (Apocynaceae) ; Idda (*Sinh.*) A slender plant 3 to 5 feet high ; flower white, throughout the year ; very common in open ground in the moist low-country, especially near the sea ; confined to Ceylon.

16. Exacum zeylanicum var. **pallidum** *Trim.* (Gentianaceae) ; Exacum. A stout herb 1 to 2½ feet high ; flower light blue, from August to October and December to February ; common among grass in moist situations up-country, up to the highest elevations ; confined to Ceylon.

17. Argyreia populifolia *Chois.* (Convolvulaceae) ; Giritilla (*Sinh.*). A usually twining creeper ; flower pale violet-pink or sometimes white, shading into red-purple in the tube, from May to September ; on roadsides and scrub jungle from sea-level up to 5,000 feet ; confined to Ceylon.

18. Ipomoea cymosa *R. & S.* (Convolvulaceae) ; Madu (*Sinh.*). A usually prostrate creeper ; flower pure white, in March ; common among grass and in jungle from sea-level to 4,000 feet.

19. Datura fastuosa *L.* (Solanaceae) ; Attana (*Sinh.*) ; Ven-umattai (*Tamil*). An annual herb 1 to 2 feet high ; flower white or purplish, from January to March ; rather common in waste places throughout the Island.

20. Strobilanthes sexennis *Nees* (Acanthaceae) ; Nelu (*Sinh.*) ; Nillu. A shrub 4 to 10 feet high ; flower bright bluish-purple, from August to April, especially October and November ; common in forests of the montane zone, especially at 6,000 to 7,000 feet, gregarious.

21. Dendrobium crumenatum *Sw.* (Orchidaceae) ; Sudu-paravi-mal (*Sinh.*) ; White dove orchid. An epiphytic orchid 2 to 3 feet long ; flower pure white with the disc of lemon yellow, sweet-scented, in December ; on tree-trunks, particularly coconuts, on the coast in the moist region.

22. Dendrobium macrostachyum *Lindl.* (Orchidaceae). An epiphytic orchid 1 to 4 feet long, pendulous ; flower very pale green or yellow, tinged with pink, lip beautifully veined with pink, faintly scented, from June to July ; on tree-trunks, common in the region up to 4,000 feet.

23. Dendrobium macarthiae *Thw.* (Orchidaceae) ; Vesak-mal (*Sinh.*) ; Vesak orchid. An epiphytic orchid with pendulous stems 1 to 2 feet long ; flower clear violet-pink, sweet-scented, from May to July ; in forests in the moist region, especially in the Province of Sabaragamuwa, below 2,000 feet, rare ; confined to Ceylon.

24. Ipsea speciosa *Lindl.* (Orchidaceae) ; Naga-meru-ala (*Sinh.*) ; Daffodil Orchid. A terrestrial orchid ; flower bright golden-yellow, from September to February ; rather common in open patanas in the montane zone from 3,000 to 6,000 feet ; confined to Ceylon.

25. Phaius wallichii *Lindl.* (Orchidaceae) ; Star Orchid, Foxglove Orchid. A terrestrial orchid 3 to 4 feet high ; flower variable in colour, often orange-brown, in April, June and from September to November ; rather common in the montane zone above 4,000 feet ; confined to Ceylon.

26. Cymbidium bicolor *Lindl.* (Orchidaceae). An epiphytic orchid ; flower reddish-purple with cream margin, from March to April ; very common on tree-trunks in the low-country up to 3,000 feet.

27. Vanda tessellata (*Roxb.*) *Hk.* (Orchidaceae) ; Tessellate Vanda. An epiphytic orchid with stems 1 to 2 feet long ; flower variable in colour, mostly grey tessellated with brown lines, sweet-scented, from March to August ; rather common on trees in the dry region.

28. Vanda spathulata *Spreng.* (Orchidaceae) ; Spathulate Vanda. An epiphytic orchid with stems 1 to 30 feet long ; flower bright deep chrome-yellow, waxy, sweet-scented, from March to September ; rather common in the dry region, on trees and in rocky places.

29. Crinum defixum *Ker.* (Amaryllidaceae) ; Hin-tolabo (*Sinh.*). A lily 2 to 3 feet high ; flower white, from March to July ; rather common near streams and in wet places in the low-country.

30. Gloriosa superba *L.* (Liliaceae) ; Niyangala (*Sinh.*) ; Karttikai-kilanku, Ventonti (*Tamil*) ; Climbing Glory-lily. A climbing creeper 10 to 20 feet long ; flower at first greenish, passing through yellow, orange and scarlet to crimson, from September to January ; common in the low-country.

31. Arisaema neglectum *Schott.* (Araceae) ; Val-kidaran (*Sinh.*). A herb 1 to 2 feet high ; flower in April and September ; rather common in the moist region up to 4,000 feet.

RESEARCH NOTES

A New Citrus Rootstock

THE Semi-wild *Heen naran* (*citrus crenatifolia var lycorpersiciformis* Lush.) which was used for the first time in the citrus stock-scion trials at the Horticultural Nursery, Peradeniya, has shown great promise as a compatible rootstock for the Seedless Bible Sweet orange and Nagpur Santra mandarin. It comes true to type from seed, which is highly polyembryonic, and makes erect vigorous growth like the rough lemon. It shows appreciable resistance to both citrus canker and scab which are common diseases of citrus in Ceylon. The fruit is sweet and not unlike a small tangerine in shape and flavour. The leaves have an aromatic smell when crushed. The seedling stocks are easy to bud, the successful 'bud take' being over 95 per cent, and the scions make vigorous healthy growth. Their performance is being watched with interest in the stock-scion trials at Bibile, Mahaillupalama and Kundasale in which rough lemon and sweet orange have also been included as rootstocks.

Of the other local citrus rootstocks under trial sour orange has again proved to be unsuitable, the stunted growth and chlorotic symptoms of most varieties budded on it being not unlike those caused by the Tristeza or Quick Decline virus. *Nas naran* (*citrus japonica var lakkanovensis*) which grows almost wild in village gardens is also unsatsfactory. Its fruits resemble the common acid lime in size and flavour, but the seedlings make very slow growth and produce short lateral shoots which have to be removed periodically from the main stem to facilitate budding. The Indian citrus variety *Kichchili* (*citrus madraspatna* Tanaka) also shows less promise compared to rough lemon and sweet orange rootstocks. The quality of fruit on rough lemon stock is, however, poor in the early years, and the trees are not long lived as those on sweet orange stock which are known to produce fruit of high quality from the start.

A. V. RICHARDS.

The 'Star' Goose-berry as a Leafy Vegetable

THE commonly called 'Star' Goose-berry, *Sauropus albicans* (B.L.), is a shrub of the order Euphorbiaceae. The Sinhalese name for it is *Mella-dum-kola* or *Rosa Murunga*. In tamil it is called *Thavasi-Murungai*.

The plant is common in Travancore, Bengal, Burma and Malaya. In Malaya it is used as a leafy vegetable in preference to many others. It was introduced into Jaffna probably from Malaya where it has since gained popularity as a very palatable leafy vegetable particularly when prepared as a *mallum*. Nevertheless, it is not cultivated in market gardens anywhere in Ceylon. It is found in the wild state in the wet zones up to an elevation of about 3,000 feet. It grows luxuriantly in humid regions as well as under irrigation.

As a leafy vegetable this was grown at the Experiment Station, Peradeniya, along with *Kathura-Murunga* (Sinhalese), *Agathi* (Tamil), (*Sesbania grandiflora*). *Kathuru-Murunga* though popular, grows to tree size in a few years and brings about a shading effect with the result that other vegetables cannot be grown successfully underneath it. Besides, it does not stand severe and continuous pruning of the new foliage and gradually begins to die back. On the other hand the 'Star' Goose-berry never attains tree size and responds to drastic pruning of its new foliage thereby assuming a very bushy habit. In the market or kitchen garden it should occupy an important place. In food value it compares favourably with *Kathuru-Murunga*.

It is easily propagated by seed as well as stem and root cuttings. Stem cuttings 6 inches-9 inches long planted 3 feet-4 feet apart in drains between two vegetable

beds serves the purpose in market or kitchen gardens for the supply of green leaf as well as the partial shade necessary for other exotic vegetables such as lettuce, carrot, cabbage, &c., particularly during dry spells. Two to three pounds of marketable green leaf from each bush can be obtained at each fortnightly pruning.

The analysis of the leaf of *Sauropus albicans* given below was done by Mr. C. Charavanapavan, Assistant Chemist (Food Technology). It shows the value of the 'Star' Goose-berry, particularly as a rich source of vitamins, A, B_1 and C, as well as iron.

Moisture	..	75·1 per cent.
Protein	..	6·93 ,,
Fat	..	1·39 ,,
Mineral matter	..	2·15 ,,
Fibre	..	1·64 ,,
Carboyhydrate	..	12·79 ,,
Calcium	..	0·244 ,,
Phosphorus	..	0·103 ,,
Iron	..	9·64 ,,
Calorific value	..	93·8 ,,
Vitamin A (I.U.)	..	6764
Vitamin B_1 (I.U.)	..	29
Vitamin C (Mg.)	..	200

E. P. BUELL.

BOOK REVIEW

Commonwealth Stock-taking—by L. St. Clare

Grondona Butterworths Publications Limited, London 1953, 35s.

FEW reference books are available which deal with the statistics of economic products of all Commonwealth countries within the compass of a single volume. In *Commonwealth Stock-taking,* to which there is a preface by Viscount Bruce, all the chief basic products of the Commonwealth countries are listed together with the volume of the import and export trade for the last 5-6 years in the principal Commonwealth countries both within and outside the sterling area. In the case of crop products there are brief notes on cultivation, on the increases or decreases in acreage over the years and the factors which have been responsible for or have hindered such increases.

There are numerous tables and coloured diagrams in which this information is recorded and these appear in the appropriate positions under each product and not together as in the case of most publications on the satistics of import and export products of a country.

In a short summary at the end of each chapter the trends in the whole pattern of trade in each product are dealt with.

The book is divided into 3 parts with a bibliography and index at the end. Part I deals with all products under food, feeding-stuffs and tobacco in the space of 7 chapters, Part II with industrial materials including fuel and power, and Part III with External investments, shipping and Insurance and a conclusion.

The type, tables and diagrams are clear and well printed. This publication is a valuable reference book which brings to light the vast resources in the Commonwealth and shows how dollar difficulties can be overcome by restricting purchases of goods only to those countries in the sterling area.

W. R. C. P.

DEPARTMENTAL NOTES

Agricultural Extension Work

A Message to all Extension Workers from the Minister of Agriculture and Lands

My recent experience of the *Wap Magul* ceremonies and the Tree Planting Campaign has convinced me that much can be achieved in the sphere of agricultural development by close co-operation in the field, between the elected representatives of the people, public workers, officers of the Agricultural and other Government departments concerned with similar activities, and the cultivator himself. There is no doubt that since the beginning of the war greater stress is being laid on extension work in the field. Extension services are intended—

(1) to convey the findings in research to their logical application in the field ; to disseminate such technical information and to assist cultivators to utilize it in improving agricultural production and to increase their incomes ;

(2) to make clear to research workers the problems faced by the cultivators ;

(3) to provide an opportunity for cultivators to discuss their common problems with each other and to learn from each other's experience.

The extension worker must also not forget to keep his contact with schools in order to become acquainted with the rising generation of farmers. The extension services provided by the Government are manned by a large number of officers, and they include the District Agricultural Officers, who are the chiefs of this service in the Provinces, and several groups of officers under them, such as Agricultural and Food Production Instructors, Overseers, and other officers. We can add to this number, officers of similar status working in the Rural, Land and Co-operative Departments. It can be safely said that extension services are organizationally relatively well staffed. The services of the public are also available. The elected representatives of the people and other public men are always willing to co-operate with these officers in helping the agricultural worker. I wish here to indicate my own views as to improvements in its functioning.

One of the criticisms made is that extension operates from the top downward, rather than from bottom upward, or as a two-way street. I am informed of a recent example of a 'drive' to get people to grow chillies when everyone was eager to grow tobacco, as it was a good tobacco area. The cultivator would have derived benefit from expert advice on tobacco cultivation. The officer for the area, however, had orders to encourage the growing of chillies. Such an approach does not establish confidence with the village population. I would stress that rather than pushing 'drives' to get people to grow what we think they should grow, officers should concentrate in supplying the cultivator with information on the crops in which he is interested, no matter what they may be. This would establish contact with him and the confidence essential for effective work.

I shall be glad if in all extension activities you will impress on your officers the necessity to consider the cultivator as the pivotal individual in all our schemes. Therefore, whatever our scheme may be, we should not create in him the impression that we expect him to do what we want. On the contrary, we should make him realize that we are technical advisors at his service. In approaching the cultivator our first object should be to find out what he would desire to cultivate, and what his wants and difficulties are. For instance, he may be lacking in funds to purchase his agricultural requirements, may lack water for irrigation, &c. He may desire to cultivate tobacco while we desire to initiate a drive for chillies. It may also happen that what we desire and what the farmer might ask will be identical ; but the phychological aspect is that we make the cultivator feel that the initiative comes from him, and that we do not appear to dictate to him.

I wish to emphasize that the extension worker should report what the cultivator wants and seek to supply his felt needs rather than carry on his work independent of these needs. I do not want extension officers to act in the role of 'all-knowing' Government officials, telling the 'ignorant and lazy' peasant what to do. They should rather be at the service of the cultivator, mingling with him in his daily work and seeking to supply the knowledge or the means which he lacks.

In our attempts to carry conviction to the cultivator with respect to such improved practices as transplanting, use of manures, &c., our method of demonstration on the cultivator's own field is the correct starting point. We often fail to carry our plan to its logical conclusion, which is to so impress on the cultivator the benefits of the new practices. We can do this by publishing widely handbills giving full details of the results, including the names of the cultivators, of the *yaya* and the actual yields, at field days and other large gatherings. In our propaganda we should remember the psychological aspect. The cultivator enjoys a 'day out'. Mass demonstrations and large-scale field days with the presence of important public workers will go a long way to win the cultivator over, as he will feel that he and his needs are pre-eminently before those in authority.

There is a definite cultural foundation within the nation which we must bear in mind in approaching the villager. The Department and the agent must recognize the importance of inter-personal relations in this culture. If we are to win the confidence of the cultivator, we should have as much contact with him as possible and make him feel that we are one with him. This is best done through village organizations, such as Rural Development Societies, Mahila Samities, &c. Attendance at their meetings is, therefore, of great importance.

In deciding the policy regarding the crop that should be encouraged in any area, we should study the special needs of the cultivators in those areas and, as far as possible, seek to meet them.

To be effective, extension services must be selected to accomplish a specific purpose. It may be to arouse interest in the eradication of some pest, or in the use of artificial insemination, or some new agricultural implement. The service must be so organized that the farmer sees immediately the value of the new method.

The method of approaching the cultivators may be a combination of individual, group and mass methods. The personal and social relationship between extension workers and the cultivator must be one of mutual trust and confidence. The officer must have the ability to speak and mix freely with all classes of people. He must have a cultivator's mind; he must be a teacher, guide and colleague to the cultivators; he must be their friend and the man in them they have complete confidence.

Turning our minds again to the two recent activities of my Ministry mentioned earlier, namely, the *Wap Magul* ceremonies and the Tree Planting Campaign, a large measure of the success which both these attained was due to the fact that both movements were not forced on the people, but kindled in them an interest which existed, and only needed the necessary encouragement to make them take part in these activities on a mass scale. In all human activity we cannot forget the value of emotion. A human being does not work like a machine; his mind and heart must move him to greater effort. I, therefore, commend to all officers the continuance of both these activities from year to year, making the people themselves organize the ceremonies through the various institutions that took part in them this year. Through these, the cultural practices that the research worker has taught us would give a better yield, or has advised us to practise, should be taught to the farmer. For example, the *Wap Magul* ceremony could be used to demonstrate the efficacy of transplanting, or the use of pureline paddy or manure, or the Japanese method of paddy cultivation. The Tree Planting Campaign may be utilized to show the value of trees in protecting soil, affording shade and in providing food.

In conclusion, I wish to thank all officers, both in my Ministry and other Ministries, who worked so hard and sincerely with the people to make these two movements such a success.

J. R. JAYEWARDENE,
Minister of Agriculture and Food.

Fourth Session of the International Rice Commission held in Tokyo, Japan, October, 1954

THE Working Parties of the International Rice Commission on Fertilizers and Plant Breeding held their 4th and 5th Sessions respectively at Tokyo, Japan, from the 4th to the 8th October, 1954, and the Plenary Meetings of the 4th Session of the Commission followed on these from the 11th to the 19th October. In between excursions to various agricultural research and production centres were made. At the conclusion of the Commission sessions a three-day tour to Kyoto and its environs was arranged for the delegates. The Working Party and Commission sessions were concerned solely with the technical problems of rice cultivation, milling and storage.

Ceylon was represented by two delegates —Dr. M. F. Chandraratne, Chief Research Officer, and myself. Dr. Chandraratne was our representative on the Working Party on Rice Breeding while I represented the Island on the Working Party on Fertilizers. There were about 100 delegates, including F. A. O. personnel attending the sessions of the Working Parties, and all the rice-growing countries of Asia, the U. S. A., Egypt, Italy and Australia were represented on them.

Dr. T. Morinaga, Director of the National Institute of Agricultural Sciences, Japan, was elected Chairman of the Working Party on Rice Breeding and I was elected Chairman of the Working Party on Fertilizers. Mr. L. N. H. Lasrter, Senior Botanist, Federation of Malaya, and Professor S. Mitsui of Japan were elected Vice-Chairmen. The technical secretaries were Dr. R. A. Silow and Dr. V. Ignatieff respectively. These Working Parties also held a joint session to discuss matters of common technical interest, viz., soil and water and plant relationships in rice production, the interaction between paddy varieties and fertilizer response, and physiological diseases of rice. Dr. Chandraratne was the co-ordinator of the project on the interaction of paddy varieties to fertilizer response and led the discussion on the subject.

The Fertilizer Working Party discussed various problems dealing with the efficient use of fertilizers on rice and the policy followed by member-countries in regard to their manufacture, distribution and usage, response curves, nitrogenous and phosphatic manuring of the crop and the methods of presentation of the data of trials thereon, the design of simple fertilizer trials for conduct on cultivators' fields, the placement of fertilizers, nursery manuring, green manuring of and crop rotations with paddy, soil analyses in relation to crop yield, the mapping of paddy lands on a geo-morphological and ecological basis, &c. The main discussions of the Working Party on Breeding related to studies on photoperiodism in rice, the maintenance of genetic records of rice, the co-operative rice hybridization project, seed production and distribution schemes, the training of junior technical workers in rice breeding and improvement programmes, linkage groups in rice, the organizing of regional variety trials to obtain data on regional adaptability of rice varieties, the pests and diseases of rice and their control, breeding of paddy for blast resistance, &c. The Ceylon delegates participated actively in the discussions on the various subjects coming within their respective Working Parties and made useful contributions thereon.

At the Plenary Rice Commission Sessions, Dr. S. Tobata, leader of the delegation of Japan, was elected Chairman. The Vice-Chairmen were Dr. P. S. Desmukh, Minister of Agriculture, India, and Leader of the Indian delegation, and Dr. W. M. Clyde, Leader, U. K. Delegation, Rice Adviser to the U. K. Government. In addition to a consideration of the reports of the two Working Parties, the main items discussed during the Commission sessions were mechanization in relation to rice production, the grading, processing and storage of rice, losses due to insect and fungal damage in storage, the nutritive value of rice in relation to methods of processing and storage, and fish culture in rice.

Among the more important decisions reached by the Commission the following may be mentioned :—(i) It considered that specialized attention should be given in future by the Working Party on Breeding to pest and disease control in rice. (ii) It decided to invite the member-Governments

of certain countries, among others Ceylon, to nominate a representative to a small *ad hoc* technical study group to study and evaluate the whole subject of mechanized rice production techniques in Asia. (iii) It recommended that comparative costs be kept by member-countries of various types of water-lifting devices and that studies on the need for and the costing of various mechanized operations in the production of rice in their particular countries be continued and extended. (iv) It considered the need for appointing an *ad hoc* technical group to look carefully into the various aspects of processing and storage of rice and to indicate the lines on which action might most profitably be taken by the Commission and member-Governments. This group would also consider the nutritional aspects of rice in relation to milling and storage processes and work in close collaboration with the Nutrition Division of the F. A. O. in this respect. In this connexion the problem of *Mildewed* or *Yellow* rice was brought up for discussion by the delegation from Japan. This condition was caused by various fungi which grew on rice in storage, two of which appeared to be harmful to the human body, viz., *Penicillium citrinium* and *P. Islandicum*. Of 1,453,000 tons of rice imported by Japan in 1953, 78,000 tons were found unfit for food because of this condition. (v) The Commission, therefore, recommended that a proper scientific investigation of the problem of mildewed rice should be undertaken by each country and the position reviewed at the next Conference.

In regard to the non-technical business part of the Agenda, the Commission approved certain minor modifications to the Constitution which had already been circulated to member-Governments.

The Commission accepted the invitation of the Indian Government made at the last meeting of the Commission in Indonesia to hold its 1956 Sessions there. Ceylon's invitation extended with Ministerial approval was noted with appreciation and will be kept in view when the venue for the 1958 meeting is considered at the Commission's meeting in 1956.

The Rice Commission is one of the most useful entities set up under the Food and Agricultural Organization for the promotion of increased food cultivation in Asia. As such, it should and does receive the full co-operation of its member-Governments, and notable advances have been made in the achievement of its objectives. It is a pleasure to record that Ceylon has given the Commission its fullest support and that its delegates have made noteworthy contributions in their respective fields of scientific study. The future holds even greater promise of co-operative achievement in this vital field of activity for South-East Asia, viz., rice production,

A. W. R. JOACHIM,
Director of Agriculture.

Rice Improvement Unit

(Extract from the Report of the Joint U. K. and Australian Mission on Rice Production in Ceylon

THE Government and the industries concerned have seen fit to set up special Research Institutes for the three major crops—tea, rubber and coconuts—yet there is no specific organization which deals exclusively with the improvement of rice. It is true that a large amount of attention is given this crop by the various research officers of the Department of Agriculture and, as a result, rice yields have been considerably increased. But these officers have other crops with which to deal and can devote only a portion of their time to rice research.

The Mission feels that the time has arrived for the establishment of a separate Rice Improvement Unit within the Department of Agriculture. This title has been chosen in preference to a Rice Research Institute because the Mission feels that the scope of the proposed organization must be wide enough to include not only fundamental research problems associated with the production, milling and storage of rice, but also the processes by which the results of such research might reach the individual cultivator in the field in the shortest possible

time. Likewise, the problems confronting the cultivator must flow readily back to the research laboratories for investigation and solution. In this manner both the research and extention services connected with the rice crop will have the advantage of being administered by the one individual and within the Department of Agriculture.

It is pertinent to recall that the Institutes concern with research on tea, rubber and coconuts are not divorced from extension and advisory work which endeavours to assist growers. In the case of the larger plantations contact is either direct with the owner or manager, or through associations of those engaged in the industry. To cater for the small producer, the Institutes have Smallholdings Divisions which carry out the extension work. We regard it as absolutely essential that Rice Research be closely integrated with the extention service concerned, both to ensure that results are effectively made available to farmers and, what is no less important, that problems facing the farmer are brought before the research workers. Research in isolation from realities can quickly become unpractical. The Mission envisages a separate Rice Improvement Unit which will have a central core of fundamental research to which is attached a field research staff testing preliminary fundamental findings and also solving local problems at subsidiary research stations or on private paddy fields throughout the Island. Problems of varietal improvement, fertilizer requirements, cultivation and weeding techniques, improvement of indigenous implements and pest and disease control should be so investigated. Working alongside the research staff will be an extension liaison officer who will collate the findings of the research team, translate them into popular language and transmit them to extension officers in the field. These officers, in turn, will proceed by demonstration, public addresses, Junior Farmer's Clubs, crop competitions and dissemination of literature to influence the cultivator to apply the latest findings of research. Thus, working together within the one Rice Improvement Unit, the results of research should become immediately available to the extension officer; the research worker has the satisfaction of knowing that his finidings are reaching the field, and the extention worker can bring the problems of the field immediately to the notice of the research worker. Above all, the spirit of camaraderie, which can thus develop between the research and extension officer within the one department, is invaluable.

It is suggested that a Director of Rice Improvement be appointed who will control the affairs of the Unit subject only to the nominal supervision of the Director of Agriculture. The first Director should possibly be an appointee from outside Ceylon, who would come for a period of three to five years. He would outline a general programme of research and set the Unit in motion. Thereafter the position of Director could very well be filled locally with a man of the requisite administrative and technical qualifications, who should have worked as understudy to overseas man.

The main lines of agricultural research in rice improvement would appear to be in improved varieties, weed control, better crop husbandry, better implements, plant nutrition, control of insect pests and diseases and some degree of mechanization. Finally, to take the information out to those who will benefit from the results of this research, an extension service will be required.

The Rice Improvement Unit might very well then fall into a number of branches such as Crop Botany, General Agronomy, Plant nutrition, Entomology and Plant pathology, and Administration, viz:

Director

Crop Botany—Rice breeding, Initial seed multiplication, Study of weeds, Biometrics.

Agronomy—Crop husbandry, Weed control, Farm mechanization, Seed multiplication (commercial), Extension Liaison Services.

Plant Nutrition—Chemical analysis, Soil surveys, Soil physics, Trace Element Research, Field fertilizer trials.

Entomology and Plant Pathology—Entomology, Plant pathology, Field quarantine.

Administration—Clerical.

The most suitable Senior Officer in charge of one of the branches would also be Assistant Director.

The Botanist would be responsible for all rice breeding work and the maintenance and initial multiplication of seed selections till sufficient seed is available for the field officers in the Agronomy branch to take them over. Rice breeding would be centred at the Headquarters of the Unit with such minimum and subsidiary selected field stations as might be required for breeding for local conditions.

The greater number of field staff would be under the direction of the Agronomist and would conduct field experiments drawn up by the other research staff in consultation with the Biometrician, conduct trials with simple implements and be responsible for their improvement, and generally be responsible for further bulk seed selection and distribution. A mechanization officer concerned with the improvement and adaptation of imported machines would be valuable. Where necessary, field staff belonging to the other branches would be provided. Most of the operations in paddy cultivation are designed to control weed growth, and as weeds take heavy toll of crop yields it is suggested that a special Weeds Officer be appointed within the Agronomy branch to investigate fully aspects of weed control. Although preliminary reconnaissance Soil Surveys have been made in a number of localities throughout the Island, it is felt that much more detailed soil survey work together with complete mechanical and chemical analyses, classification and mapping are required before paddy nutrition can be thoroughly investigated. It is, therefore, suggested that a Plant Nutrition Section be set up, the functions of which will be to organize soil survey and mapping and then conduct plant nutrition studies on the various soil types. This soil survey work could be linked with a wider complete soil and land use survey of the whole Island which is being referred to elsewhere. Most cultivated land throughout the world has been shown to be deficient not only in the major nutrients, but also in one or more minor or *trace elements* which, in varying degrees, affect crop yields. Little, if any, investigational work on trace element nutrition in paddy has been conducted and it is reasonable to expect that this will prove a profitable field of research which the Plant Nutrition division might investigate.

It has been suggested to the Mission that initially an Entomologist and Plant Pathologist would not be required, but it has been estimated that a 15 per cent. reduction in rice yields is due to the attack of pests and diseases and hence these two appointments are fully justified and there are plenty of immediate problems for such officers to investigate. Further, with the development of pureline paddy, a certain degree of resistence to various pests and diseases will be established within varieties. It is essential, therefore, that susceptible varieties be eliminated as quickly as possible and that the breeding programme includes entomological and mycological work. In addition, new pests and diseases will arise from time to time and immediate restriction of their spread will be demanded. Every effort should, therefore, be made to establish quarantine facilities and regulations and provision for enforcing them. This function of plant quarantine could be most adequately handled by the branch concerned with entomology and plant pathology. The location and equipment of such a Rice Improvement Unit can very well be left to the Government of Ceylon. Finance for such an Institute might well be brought to the notice of Colombo Plan Member-Governments. An estimate of the cost of establishment of such an unit has been made by the Department of Agriculture, the figures being Rs. 3,045,000 for the headquarter unit plus Rs. 998,000 for four additional sub-stations and the additional equipment for the present Batalagoda Research Station, making a grand total of Rs. 4,043,000. We would, however, urge that because the Department has already a rather large number of farms, it should be accommodated on existing departmental land if possible. This applies also to the sub-stations.

An approximate estimate of the capital cost of this proposal is Rs. 4 million.

CENTRAL BOARD OF AGRICULTURE

PROCEEDINGS OF THE SEVENTH MEETING OF THE CENTRAL BOARD OF AGRICULTURE HELD AT THE CEYLON CHAMBER OF COMMERCE, COLOMBO, ON AUGUST 26, 1954

Dr. A. W. R. Joachim, Director of Agriculture, presided.

The Hon. Mr. J. R. Jayewardene, Minister of Agriculture and Food and Mr. K. Alvapillai, O.B.E., Permanent Secretary, Ministry of Agriculture and Food, were associated with the Chairman, on the dais. The Minister of Agriculture and Food delivered an address in the course of the meeting.

The following Members of the Board were present :—

Mr. C. A. M. de Silva (Vice-Chairman); Mr. N. Manicka Idaikkadar, C.C.S., Director of Food Production; Mr. A. M. Clement Dias; Mr. S. Pathmanathan; Senator Thomas Amarasuriya, O.B.E.; Mr. S. Pararajasingham; Mudaliyar N. M. Abulcassim Maraikar; Mr. S. H. Mahadiulwewa, M.P.; Mr. S. Sivapalan; Mr. T. C. Rajaratnam, J.P., U.M.; Mr. S. L. Bandara Dharmakirti; Mr. R. T. Chelliah; Dissawe H. B. Rambukwella, M.P.; Mr. A. Godamune; Gate Mudaliyar N. Wickremeratne; Mr. K. Kanagaratnam; Mr. K. Morford, C.B.E.; Mr. W. M. Cumaraswamy; Sir J. P. Obeysekera; Senator (Mrs.) Clodagh Jayasuriya; Senator (Miss) Cissy Cooray, O.B.E.; Senator (Lady) Molamure, O.B.E.; Muhandiram S. Armstrong; Mr. S. C. Fernando, C.C.S., Commissioner of Co-operative Development; Mr. J. M. Sabaratnam, D.R.O.; Mr. Gladwin Kotalawala; Mr. M. B. Samarakoon, D.R.O.; Mr. L. B. Rajakaruna, Deputy Commissioner of Marketing; Mr. S. Thondaman; Mr. S. Vytilingam, M.P.; Mr. R. Singleton-Salmon, C.B.E., M.P.; Mr. R. H. Spencer Schrader, J.P., U.M.; Dissawe S. A. I. Elapate, M.B.E.; Major E. C. de Fonseka, M.B.E., E.D.; Mr. Ray Wijewardene; Mr. F. A. Wickramasuriya; Mr. D. G. Dayaratne, C.C.S., Director of Rural Development; Mr. C. P. de Silva, M. P.; Mr. S. A. Selvanayagam, O.B.E.; Mr. N. R. Rajavarotham, M.P.; Mr. A. D. Paranavitane, J.P.; Mr. H. S. Hirst; Dr. H. E. Young, Director, Rubber Research Institute; Mr. F. C. Cooke, Director, Coconut Research Institute; Mr. R. A. de Rosayro, Senior Assistant Conservator of Forests; Mr. E. Muthukumaru; Mr. Vernon Rajapakse and Mr. A. J. Joseph, C.C.S., Assistant Director of Agriculture (Administration)—Secretary.

Mr. D. C. L. Amerasinghe, C.C.S., Assistant Secretary, Ministry of Agriculture and Food, was present as a visitor.

The following officials of the Department were also present by invitation :—

Mr. C. N. E. J. de Mel, Deputy Director of Agriculture; Dr. P. G. Malkani, Acting Deputy Director of Veterinary Services; Dr. M. F. Chandraratne, Chief Research Officer; Mr. D. M. Ratnatunga, Chief Agricultural Engineer; Mr. P. T. Jinendradasa, Divisional Agricultural Officer, Western Division; and Mr. T. Wickremasinghe, Soil Conservation Officer.

Letters and telegrams regretting inability to attend the meeting were received from the following :—

Mr. Marcus S. Rockwood; Mr. P. B. Bandaranayake; Mr. Anton Ponnampalam, J.P.; Mr. M. Atkinson; Mr. H. A. Pieris; Mr. Victor Ratnayake; M.P.; Mr. T. B. Naranpanawe, D.R.O.; and Mudaliyar M. M. Ebrahim, M.B.E., M.P.; Sir Wilfred de Soysa; Mr. C. J. Strachan and Mr. J. Lamb, Director, Tea Research Institute.

I—Confirmation of the Minutes of the last Meeting

The minutes of the last meeting of the Central Board of Agriculture were confirmed.

II—Address of Welcome to the Hon. Minister of Agriculture and Food

Chairman—" This is the first occasion on which the Hon. Minister is with us. No sooner was he appointed Minister of Agriculture and Food I took advantage of the opportunity to inquire from him whether he would preside at one of our Board meetings and hear at first hand what members of the Central Board of Agriculture had to say on agricultural matters. The Hon. Minister stated that he would first like to acquaint himself with the agricultural problems facing the country. He has now been Minister for just about a year and during this time has not spared himself in becoming familiar with various aspects of local agriculture. Today the Hon. Minister is with us to participate in our discussions and to give us the benefit of his direction and guidance. I welcome you, Sir, on behalf of the Central Board of Agriculture and assure you that your presence here will be a source of encouragement and inspiration to the activities of the Board.

This Board, as you know, is an Advisory Board, it is not an executive Board in the sense that the Coconut Research, Tea Research and Rubber Research Boards are, but it has always played a useful part in conveying to the Minister the views of members on all subjects connected with agriculture. It is true that it has not always been possible for the Minister to give effect to all the resolutions passed by the Board, as there were certain practical difficulties in doing so. But I can assure members that the resolutions of the Board have always received the consideration of the Minister and that full details of our discussions have always been forwarded to the Minister for his consideration.

Today we have a continuation of the discussion on the subject of Food Production which was started at our last meeting. We hoped to meet at an earlier date, but unfortunately owing to the difficulty of finding a suitable meeting place in Colombo, we were prevented from holding the meeting until now. As you know, the meetings are usually held in Peradeniya but in order to give more members the opportunity of being present at the meeting we decided to hold it in Colombo.

I would once again think you, Sir, for your presence and for the encouragement you have given us by coming here to participate in our discussions."

III—Election of Members to the Agricultural Machinery Advisory Board

Chairman—" The next item on the Agenda is the election of 2 members of the Board to serve on the Agricultural Machinery Advisory Board constituted by the Minister of Agriculture and Food. I do not want to say very much because I am sure the Hon. Minister will in the course of his address later on make reference to this subject. One of the first acts of the Hon. Minister after assuming office was to appoint an Agricultural Machinery Board to review the problems of agricultural mechanisation in Ceylon and to effect co-ordination which appeared to be lacking at the time. He has directed me to ask members of this Board to nominate two members to serve on this Advisory Board. I would therefore call for nominations from members."

Messrs. M. Atkinson and Marcus Rockwood were elected.

IV—Election of Members of the Board to Advisory Sub-Committees

Chairman—" Item (4) is the election of members of the Board to constitute 4 Advisory Sub-Committees on the following :—

(*a*) Paddy.
(*b*) Animal Husbandry.
(*c*) Poultry Husbandry.
(*d*) Minor Products.

This again, Ladies and Gentlemen, is a proposal which has come from the Ministry itself, and it is one which we should act on. I would like to mention, however, that we have already divided ourselves into 3 sub-committees, viz., for Food Production, Animal Husbandry and Permanent Crops.

Up to now, as I mentioned at the last meeting, it has not been found necessary for these sub-committees to meet because the problems discussed so far have been of a somewhat general nature. But the Hon. Minister desires that we should have 4 Advisory Sub-Committees which would meet regularly and give him guidance on these subjects. It is not intended that these Sub-Committees should be entirely composed of members of the Board. But with the Hon. Minister's permission I might ask whether he desires that there should be two separate Sub-Committees for Animal Husbandry and Poultry, or whether it would suffice if we have one Sub-Committee for Animal Husbandry and Poultry as both subjects are closely related."

Hon. Minister wished to know the views of the members. It was put to the House and members agreed that one Sub-Committee should suffice for both Animal Husbandry and Poultry.

The House then proceeded to nominate members to the three Sub-Committees :—

(a) PADDY

Dr. M. F. Chandraratne (Convenor)

Mr. A. M. Clement Dias

Mr. A. Godamune

Gate Mudaliyar N. Wickremeratne

Mr. Anton Ponnampalam, J. P.

Mr. S. Sivapalam

Mr. U. B. Unamboowe, M. P.

Mr. S. H. Mahadiulwewa, M. P.

Mudaliyar S. Armstrong

(b) ANIMAL HUSBANDRY (Including Poultry)

Dr. T. M. Z. Mahamooth (Convenor)

Mr. W. M. Cumaraswamy

Major E. C. de Fonseka, M.B.E., E.D.

Mr. R. H. Spencer-Schrader, J.P., U.M.

Mr. R. H. de Mel

Mr. Vernon Rajapakse

Mr. S. Pararajasingham

Sir J. P. Obeysekere

Mr. C. J. Strachan

Mr. A. M. Clement Dias

(c) MINOR PRODUCTS

Mr. A. V. Richards (Convenor)

Mr. P. H. C. de Silva, M. P.

Mr. Kenneth Morford, C.B.E.

Mr. S. Pathmanathan

Mr. A. Hensman

Mr. S. Vythilingam, M.P.

H. B. Rambukwela Dissawe, M.P.

Senator (Mrs.) Clodagh Jayasuriya

When Mr. Clement Dias' name was suggested to serve on a second Sub-Committee, the Chairman pointed out that it would be better if each member served on only one Sub-Committee.

Mr. S. C. Fernando, Commissioner of Co-operative Development, enquired whether if a member was competent, experienced and had the time to serve on two Sub-Committees he should not do so.

Chairman—"We agree on the issue, but we did not think it fair to take Mr. Clement Dias away from other duties. We know he is already the President of the Stock Breeders' Association. If, however, Mr. Clement Dias is prepared to serve on two Sub-Committees, there is no objection."

It was agreed that Mr. Clement Dias would serve on both Sub-Committees.

Mudaliyar S. Armstrong—"Sir, before we start discussion on the memoranda of Gate Mudaliyar Wickremeratne and Mr.

Godamune, I wish to bring up an important issue that has arisen. You will see that in the Hansard of July 20, 1954, there is reference to a proposal to divide the Department of Agriculture into two sections—Research and Extension Services. As the Hon. Minister is also here I would like to say that we are his advisers and that we should be allowed an opportunity of debating this very important issue on some future date in the presence of the Hon. Minister. I hope, Sir, you will kindly bear this in mind and consult the Hon. Minister and let us know whether this could be discussed at a later date".

Chairman—"I have discussed it with the Hon. Minister and he will refer to it in his speech. The Hon. Minister will welcome a discussion on this subject at one of our later meetings."

V—Discussion on Gate Mudaliyar Wickremeratne's Memorandum on Food Production (paras 6-10)

Chairman—"Item (5)—Continuation of discussion on Mudaliyar Wickremeratne's memorandum. You are no doubt aware of a very full discussion having taken place at our last meeting on paras 1 to 5 of Mudaliyar Wickremeratne's memorandum. Today we propose to continue discussion on the remaining paragraphs of Mudaliyar Wickremeratne's memorandum and also to consider along with them the memorandum of Mr. Godamune on "The Case for the Establishment of a Paddy Rehabilitation Scheme for Ceylon", which is also covered to some extent in Mudaliyar Wickremeratne's memorandum.

I would now ask Mudaliyar Wickremeratne to address the meeting."

Gate Mudaliyar N. Wickremaratne then addressed the meeting on items (6) to (10) inclusive of his memorandum of November 17, 1953, of which items (1) to (5) inclusive had been discussed at the preceding meeting of the Central Board of Agriculture.

The subjects dealt with by the speaker were the following :

(*a*) A clear cut policy should be laid down to meet the increased production by gradual reduction of imported rice annually until the goal is reached in the production of paddy to meet local demand. No import of rice should ever exceed the required deficit.

(*b*) The question of regulating the work of Co-operative Societies on pure co-operative principles with a view to utilize the movement in a more comprehensive manner for production and distribution of food among the members of Co-operative Societies among the producers and as well as the consumers should be reconsidered and planned.

(*c*) Endeavours should be made to prevent the millers and importers of rice interfering with the present policy laid down by the Government in the case of paddy production.

(*d*) It is very necessary that the planners and supervisors and administers of paddy cultivation should spend more time with actual direction and supervision of cultivation in the field.

(*e*) The work of Director of Agriculture, the Director of Food Production and the Director of Land Development should be reconsidered with a view to remove unnecessary overlapping and exercise more rapid and economic performance of their duties.

At the conclusion of Gate Mudaliyar Wickremaratne's speech the Hon. Minister of Agriculture and Food stated that he had taken due note of the matters raised by the speaker and would give favourable consideration to the implementation of the proposals made by him.

Mr. A. M. Clement Dias—"In the Kurunegala district fairly good work is being done to produce more paddy. This is not the case in other districts. Today you do not get a good crop in the Ratnapura district. When you sow 2 bushels you cannot get more than 8-9 bushels in the Ratnapura district because the seed paddy you have given in that district is very poor. Although there are buffaloes in that district, the men thresh their paddy. Buffaloes are not used for that work. If proper methods are encouraged in that district you will get more paddy."

Mr. C. P. de Silva, M.P.—"I could not hear properly what the Gate Mudaliyar said, but I think we are discussing the agricultural part and not the entire Co-operative movement. I think, Mr. Chairman, these C. A. P. & S. Societies are greatly inconvenienced by the failure of Government to purchase all the paddy the Societies purchase. This difficulty is a serious one in the light of the money that is held up. In fact, I discussed this matter with the Deputy Marketing Commissioner this afternoon. The Minneriya C. A. P. & S. is in a position to mill 6,000 bushels of paddy per week, but it can sell only 750 bushels. Therefore, there is always a large stock remaining in the hands of the Society. Wherever a Society has milled rice, I think Mr. Chairman the Government should buy the whole lot. Otherwise, you will cause a fair amount of trouble to the producer.

The other matter I wish to bring forward is inadequate storage. A good portion of the available storage for local paddy appears to be occupied by imported rice, especially under the Burma agreement. As a result the C. A. P. & S. Societies are precluded from purchasing all the paddy offered by the producer, who is thereby forced to sell in the open market at a leser price. Thus the whole purpose of the Guaranteed Price Scheme is lost. I would urge upon the Government to give a guarantee that all the paddy offered will be purchased.

VI—Mr. A. Godamune's memorandum: "The Case for the Establishment of a Paddy Rehabilitation Scheme for Ceylon"

Chairman—"Now we come to the next item—discussion of Mr. Godamune's memorandum on 'The Case for the Establishment of a Paddy Rehabilitation Scheme for Ceylon.' I call upon Mr. Godamune to open the discussion."

Mr. A. Godamune—"Mr. Chairman, Ladies and Gentlemen: I do not think I should waste your time by reading through my memorandum. I shall take it that you have read through it. I would, however, like to add a few words to ask your co-operation in what I suggest. What I have suggested in the memorandum is the immediate establishment of a Paddy Rehabilitation Board, firstly, to prepare a Paddy Rehabilitation Scheme and plan it out and, secondly, to put it into operation. Those of you who have read the memorandum will have some idea as to why I suggest a Board. To summarize, I would like to say that the gravity of the Island's food situation is one of the reasons why a separate Board is necessary. From about 1924 we have had a rice shortage, that is from about nearly 30 years ago. During this period we have tried various experiments, but none of them have as yet succeeded in bridging the gulf between requirements and production.

The second reason for the establishment of a Board is that the Island's economic position is in dangerous state. If by any chance the price of Tea drops as it did in 1922 or 1923, or the price of Rubber drops next year, the Government will not be able to feed the population of this Island. Therefore, the economic position is very dangerous and special attention should be paid to increased production.

Thirdly, the time factor is important. The sooner we set up a Board the better.

Fourthly, in order to co-ordinate the work. Today lot of energy is being dissipated and there is a lot of overlapping. There is the Food Production Department, the Land Settlement Department, the Rural Development Department and various other departments with various Heads and various officers in the field, and nobody is responsible. Not one person is responsible to answer for the shortage in production. My suggestion, therefore, is that in order to get somebody responsible, a Board should be set up, and the Board will be responsible.

Fifthly, a Board should be appointed in order to pinpoint public attention to this most important and urgent subject. The attention of the whole country should be pinpointed to this very serious problem.

Lastly, a Board is necessary in order to obtain some kind of planned action. We should not depend on the fads and fancies of some particular individual here or there. The problem, as a whole, should be thought out, planned and put into operation.

For those reasons I suggest that a Paddy Rehabilitation Board is an immediate necessity.

Those of you who have read the earlier memorandum and those of you who have read this one will know the very great necessity for the rehabilitation of the paddy field. The World Bank Report says that the major economic problem of Ceylon can only be solved by concentration on the rehabilitation of the 900,000 odd acres of asweddumized fields already in existence. Why is the rehabilitation of the paddy field necessary ? Many people do not know. In the past we attributed poor production to the primitiveness of the peasant, the primitiveness of his implements, the want of fertilising and various other factors, and we have taken various steps to meet them. But the real difficulty has not been realized. The real difficulty is this : that these paddy fields in the wet zone, just as much as in the dry zone, are specially built up constructions. Often you find masonry works and often you find that the levelling has been done at great labour with scientific skill. Now you will find that, even in the wet zone, every small range of paddy field had an irrigation system just similar to the irrigation system you are now developing in the dry zone, with provision for conservation in a tank, with provision for distribution towards channels, so that water can be had when necessary. It is only in the wet zone that some scheme has been adopted in a miniature form. Instead of elaborate channels you will find an existing water course made into a channel. Now, in the Kandy District, before the Sinhalese New Year, that is the 13th of April, the sowing must be finished. If it is delayed, the produce will be very much less. As an example, in my own paddy field last year, what had to be sown in March was only sown at the end of April or even early May. The net result was that the crop was 50 per cent. less. Now, immediately you start ploughing a paddy field you have to drain it off before you sow or plant. Sometimes, in about a fortnight's time after the plants have taken root, you have to flood it again with water. Then there is a stage when they are blossoming and you have to remove the water. Then again when the seeds are forming you have to flood it again. All this is possible only if there is conserved water with proper arrangements for distribution. All this has been destroyed. Nobody knows how. During the 1818 rebellion the British destroyed these as a military measure. In the 1848 rebellion they were destroyed again, and in addition to this calculated destruction there was a period of neglect for 150 years, and a period of absolute neglect, when the construction of all these paddy fields had broken away. Most of these tanks have been sold to the surrounding estates, the channels are not there and the cultivator today improvises whatever is available so that the paddy produced today is on improvised methods. The wonder is that in spite of all those hardships the men have been able to produce even this quantity. The extent of the deterioration is very great ; it is spread all over the Island. All that requires considered work. Restoration work cannot be

taken province by province ; you cannot take it district by district ; you may not be able to take it village by village ; you will have to take it individual block by individual block ; because the damage differs one from another. Only a Board devoting all its time can concentrate on that job and plan and execute a resurrection of these paddy fields. Such a Board will have to inaugurate an Island-wide enquiry and from these plan out a scheme of distributing work and money and obtain the peasant's co-operation to work and supervise these fields. If the Board works continuously, it will not only solve the Island's major economic problems but it will regenerate the peasant masses ; it will be real rural development par excellence. The whole aspect of the country will change and rural development in the real sense would then have been achieved. In short it will be the greatest agricultural achievement of the Agricultural Department. In regard to the composition of the Board, the whole subject being an economic one, an experienced economist must be there. Then, being an agricultural subject. the Head of the Agricultural Department must be there. Much of the work being irrigation work, a representative of the Irrigation Department should be there. As it would be rural development work, the Head of the Rural Development Department should be there. Much of the land where old tanks stood are today parts of estates. To cite an example : In Morgan's estate was included a tank. During the 1934 epidemic the local Ratemahatmaya got Government's permission to repair that tank with relief labour. The result was that below that tank there are 3 or 4 to be repaired. Take for instance my own village. The paddy fields have dwindled down from about 100 acres to about 50. Today it is expanding ; there is plenty of water. Portions that have been given up are being renovated and are being brought under the plough. Then, as land acquisition would have to be done, the Ministry of Lands & Land Development should be there. The laws that existed in the Sinhalese times for the protection of paddy fields are not there today. All those rules have been destroyed. There are some irrigation rules that are not given effect to at all. There are V. C. rules that are not observed. All these have to be put right and for that purpose a lawyer should also be on the committee. The scope of the Board should be really to rehabilitate the existing 900,000 acres of asweddumized land and to reclaim those abandoned in the near past. The objects cover rural development as described under the Colombo Plan for the employment of the unemployed and under-employed labour in rural Ceylon on the construction of houses, roads, bridges and to improve methods of agriculture and general works. I would leave out of it houses, roads and bridges for the time being and say that labour must be used for the improvement of agriculture so that we may get out of the economic impasse in which we are placed at the moment. The 1952-53 Budget provides Rs. 50 million for rural development. The International Bank for Reconstruction & Development recommends for irrigation works Rs. 187 million, land development Rs. 200 million, agricultural extension Rs. 30 million and rural development Rs. 60 million. The Bank's recommendations are based on a closely reasoned and carefully allocated employment of the nation's financial resources. Finance is not a difficulty because for this programme of work of rehabilitation of the paddy fields in the wet zone a fraction of the money that has been already estimated may be sufficient. The money today allocated to Government Agents, Assistant Government Agents and Divisional Revenue Officers for minor irrigation works is unspent. That money alone may be sufficient to carry out this programme. Therefore I would ask you to support this proposal and convey our opinion to the Minister for submission to the Cabinet."

Mr. S. Sivapalam—" The views expressed by Mr. Godamune on the rehabilitation of the paddy industry are very good, but I am opposed to the establishment of a Paddy Rehabilitation Board. District Agricultural Committees were formed for the purpose of looking into the requirements of paddy fields as well as of paddy field owners. The set up has functioned satisfactorily except for one or two points which have been mentioned by Mr. Godamune. There have been instances where money allocated to Government Agents have not been properly used and returned back. In certain areas many of the schemes suggested for the development of paddy fields have not been completed on acount of financial difficulties.

As regards the formation of a Board, it appears to me a very simple problem. We have in this Island about 900,000 acres under paddy, with an equal extent of undeveloped land. Our self-sufficiency is 35 to 45 per cent. and the annual increase in population is 200,000. Thus even if all the land available in the Island is brought under cultivation and the existing fields improved, the problem of self-sufficiency would still exist. It appears to me that the only way of solving the problem is to increase the yields of paddy as is done in other countries. Like Italy and other countries where the yields are about three times ours, we should try to step up our yields 2 or 3 times those now obtaining."

Mr. C. P. de Silva, M.P.—"Mr. Chairman, I wish to offer a few comments. Personally, I agree that we do not need a Rehabilitation Board as such, because, as you know, Mr. Chairman, in every District we have a District Agricultural Committee."

Chairman—"I do not consider this as a motion."

Mr. A. Godamune—"I suggest that it be moved as a proposal."

Mr. C. P. de Silva, M.P.—"Although I agree with the necessity of rehabilitating the paddy fields, personally I do not think a Board as such is necessary, because we already have the machinery for this work. We have our Food Production Committee on which all Heads of Departments are there under the Chairmanship, I presume, of the Permanent Secretary, Ministry of Agriculture and Food. Again, in every District there is a District Agricultural Committee on which you have the representatives of the local Departments and also others in the District. What is really necessary is a co-ordination of this work and central direction on policy by the Minister.

Secondly, all this means irrigation facilities. We have to do more work on our Village Works' priority lists. Much more work has to be done, because about 80 per cent. of our existing paddy fields come under Minor Irrigation Schemes, and 20 per cent. under major irrigation schemes. Therefore, we must have a change in direction of our policy: much more attention than is paid now should be paid to the minor irrigation schemes; more Engineers and more staff should be put on the job. Today we are struck without sufficient Irrigation Engineers, because of the great number of them employed on major irrigation schemes. Then of course is the question of funds, and the question of rehabilitation itself. It is much more than just providing irrigation facilities. It is more than simply providing drainage facilities. You got to have a soil survey of the area. There may be other things like water-logging or lack of water. If all these are attended to, then we automatically have our rehabilitation.

Now, for all this funds are required. If you look at the funds voted for this year and the next year for minor irrigation works it would be clear how little has been set aside for this important item. There should be a more serious effort made in the matter of minor irrigation works. I would even urge, Mr. Chairman, another Department of Irrigation under the Ministry of Agriculture and Food to go into these minor works, because the present department believes in major schemes. The minor schemes are more important. Therefore, I urge that the Government should pay more interest to these minor schemes and not merely lip-service. Money must be voted, more staff should be provided, even if we go to the extent of a new Department of Irrigation with practically utilising half the present engineers available. You got to provide as much money for minor schemes as for major schemes and just as many Engineers. The Department of Agriculture should go into the question of soil surveys. You will find, Mr. Chairman, in the latest report of the Tropical Agriculturist, reference to a particular disease in the soil. That type of thing must be looked into. Boards alone would not do—you want money and you want more Engineers."

Mr. A. M. Clement Dias—"When you come to see, I am a practical farmer. Today I am harvesting as well as sowing. I am also trying out certain experiments. Now, I harvested recently with 3 months short—term pady in a small place for certain experiments and I got 28 bushels of paddy, but out of that I was able to get only 3 bushels—25 bushels were empty. That means that more propaganda work is necessary.

As Mr. Godamune has stated, I am lucky as I have a small paddy field and am able to get my water as I like. For good paddy cultivation what is required is for you to be able to get in water when you like and to send it out when you want. For example they say in Japan that stagnant water is not good and that to get a good crop you must be able to send away the water as it comes.

This year Dr. Joachim and others paid a visit to my paddy field. They came just to please me but went away quite satisfied with the work I was doing.

Today we have to thank the Department of Agriculture for the wonderful kinds of paddy at our disposal. Some of them give very good yields. Everything is there: We have all the Vel Vidanes and other officers. What is required is planning. What I feel is that today the Government has a lot of money but they are not spending it properly. I feel that we can easily with more planning double the output of rice from the 900,000 acres of land under paddy. If you have a proper scheme you can do wonders."

Mudaliyar S. Armstrong—"I would like to point out that the portion of Karadian Aru Farm which was condemned by the Soil Chemist is now showing good results. On last year's cultivation there was a yield of 30 bushels per acre. On experiments conducted with V. I. paddy on 171 acres there was a yield of 40.96 bushels per acre, which works out to 20.48 as 2 bushels were sown per acre. Then again 2 acres of V. I. Paddy were tried out according to Japanese methods, and there was a yield of 76 bushels per acre.

Now it will be seen that with the available land under paddy we could provide our requirements. There is however the difficulty of rainfall. This has been caused by the alarming rate at which forests are being cleared up. With so many major schemes coming up a number of forests have also been cleared up. Especially in the Gal Oya valley where so many trees have been felled, you will find that the rainfall has considerably decreased.

I feel that if proper methods of cultivation are adopted by the villagers as well as others owning land, our yields could be doubled or even trebled. If we want to step up our yields it must been seen that the producer, epecially the farmer, is given every encouragement and assistance. Equally important is the fact that he be able to sell all the paddy produced at the guaranteed price of Rs. 12. If the Hon. Minister during his lifetime as Minister of Agriculture & Food would like to see that sufficient food is produced in Ceylon he must see to it that all the paddy produced in Ceylon is purchased at the guaranteed price."

VII—Address by the Hon. Mr. J. R. Jayewardene, Minister of Agriculture and Food

Hon. Minister—"Mr. Chairman, Ladies and Gentlemen: I am very glad I have had this opportunity of meeting this very important organization, the Central Board of Agriculture today. I have been trying to meet you for some time, and I think it was primarily my fault that we were unable to contact each other earlier. I was not keen to meet you during the first few months of my term of office because I was a novice at agriculture, and I thought I would find myself at sea in discussion with such people as agriculturists, cultivators, paddy cultivators, animal husbandry experts and others taking part in the discussions. After that, unfortunately I fell ill for a few months, and we are meeting today for the first time since I assumed this very important office in October last year. I wish I could have addressed you at some length today. In my speech on the 2nd reading of the Budget I spoke for 2 hours on the policy of my Ministry, but I do not intend to go over all that today. I have suggested to Dr. Joachim that he should get the relevant portions of that speech in the "Tropical Agriculturist", which I understand is circulated to all members of the Central Board, so that you may have a comprehensive idea of the agricultural picture and the co-operative policy of the Government today. We may then be able to meet each other at the next meeting with some knowledge of our respective views, for I find I am entirely in agreement with many of the views expressed today, some of which I am already seeking to implement. For example, with regard to

the growth of the Co-operative Movement, particularly the Stores Movement, I feel that we imposed it from above. Gate Mudaliyar Wickremeratne said that it was political. It was not political; it was started purely as a means of distributing scarce commodities through the machinery of the people themselves. We are trying our best to find out the defects in that part of the Co-operative Movement, and the Parliamentary Committee, I thought was sufficiently comprehensive and had sufficient knowledge to advise the Ministry. Their report will be made available for public discussion. As regards paddy cultivation too, I agree very much with some of the views that Mr. Godamune and others have expressed, and, as I will show in the course of my speech, we are seeking to implement them.

Let me first begin with the three major crops—cash crops, as they are called—Tea, Rubber and Coconut to develop and safeguard which, I think the Central Board of Agriculture was first constituted. Today I find a complete absence of discussion on Tea, Rubber and Coconut at this conference. Still they form 80 per cent of the revenue-producing products of this Island. I wonder whether it is a compliment to the work of the State in relation to Tea, Rubber and Coconut that you have completely omitted mentioning it, or is it that paddy and food production have assumed a large role in our contemporary activities that members of the Central Board of Agriculture seem to concentrate on those aspects more than on anything else? Tea, Rubber and Coconut today, as far as the State is concerned, have their own Research Institutes their own Advisory Boards, and are largely self-governing institutions or industries. The State gives, of course, whatever aid that is needed. Out of the funds so magnanimously given, through the Tea Research Institute, through the small holders scheme and the co-operative societies we are seeking to help the small holder of tea to produce a better crop and to sell the crop he produces at a better figure. Through the Coconut Research Institute we are giving all help to the coconut grower. We have given the Coconut Research Institute all the money it needs by way of increased cess and we are seeking again to rehabilitate the coconut industry as far as replanting and production are concerned. Through the Rubber Research Institute, at least with their co-operation, we have started on a scheme of rehabilitation of the rubber industry by growing high-yielding seed and clones. You may, therefore, rest assured that the State has always, as part of its concern, the welfare of the Tea, Rubber and Coconut industries, and whatever you suggest will always be considered carefully and, if possible, given effect to by the State.

As regards food production, we are coming to something that looms very large in our lives today, particularly the production of paddy. I am glad that the production of paddy has been emphasized in Mr. Godamune's memorandum as well as in his speech, because I myself feel that we must concentrate first on paddy production, second on paddy production and third on paddy production before we set out on other schemes and innovations. Paddy production, as Mr. Godamune pointed out, depends on land, on irrigation. There are so many other factors, such as the control of pests, the use of high-yielding material, good cultural practices, and so on. No one can say that the State has not devoted much time and money to the increase of paddy production in Ceylon, not only by the opening up of new land but by the intensive cultivation of the old land, as Mr. Armstrong point out. Whether the Paddy Rehabilitation Board is one way of increasing our yield I cannot say at present, but I would certainly like that matter discussed by the Paddy Advisory Board more fully than we are able to discuss in a general body, in the presence of the officials concerned, in the presence of officials of other Ministries, such as the Ministry of Lands and the Ministry of Home Affairs—rural development is a function of the Ministry of Home Affairs—so that you may be able to prepare a more comprehensive, a more detailed, scheme than you have been able to place before us today. I would like to say that minor irrigation schemes are not being neglected. Under the votes of the Ministry of Lands a sum of Rs. 6 million has been allocated for minor irrigation schemes, and under the Director of Food Production a sum of Rs. 2½ million has been

allocated for expenditure in the current financial year—almost Rs. 10 million for minor irrigation schemes—and whatever scheme is put up by the District Agricultural Committee we have been in a position to implement it, so much so that even Opposition Members of Parliament have expressed satisfaction. Mr. Suntheralingam, who, as you know, is one of the most formidable critics of the Government, was able to say both in the last Budget and in this that every single minor irrigation scheme in his electorate had been completed. Mr. Suntheralingam says that everything he could want was done. In other areas too schemes of the District Agricultural Committee have been completed. The money is available. It is not a question of non-availability of money, but I think it is a question on non-availability of staff, or irrigation engineers, investigating the problem and trying to find out what the villager wants. Very often the villager is correct, but what he wants done is sometimes damaging to the whole scheme. So we cannot spend money without having expert advice and we have to proceed carefully. The State has accepted the policy today that minor irrigation works must be given the highest priority and all the money necessary was provided in the last 4 or 5 years which was not the policy in the past. Money has been voted to the District Agricultural Committees and Government Agents to carry out the minor irrigation schemes which they can do with the Votes of the Director of Food Production.

Again, another innovation has been the creation of the Paddy Research Branch of the Agricultural Department to which we have appointed the Staff. As a first step towards the creation of a Paddy Research Institute, a Faculty of Paddy Research, I am in touch with the world-famous paddy expert, Dr. Mitsui of Japan, and immediately he comes out I will ask him to investigate the possibility of opening a Paddy Research Institute in Ceylon which may possibly be inaugurated at Maha Illupulama in the N.-C. P. With the Paddy Research Institute as a beginning we may be able to have all our paddy research farms and our seed stations to be worked under the auspices of the Paddy Research Institute. So you see, some of the ideas that members of the Central Board of Agriculture have been urging for several years are now coming into fruition.

With regard to the distribution of seed paddy of high-yielding variety, everybody knows that the State has made that one of its prime concerns in the production of proper pure-line and the distribution of that proper pure-line. In the North-Western Province and in the North-Central Province it is functioning very well. The Vel Vidanes themselves are taking an interest, but in the Southern Province we have not been able to find the proper seed which can be distributed, particularly in the wet zone. But that is also being looked into. Dr. Chandraratne who is the officer primarily concerned will tell you that they are experimenting on various types of pure seed, some of which have given very good results.

Then we come to the question of other cultural practices. The State is giving manure at a subsidised rate of 33, 1/3 per cent through C. A. P. & S. Societies every year and the amount of acreage cultivated with this manure is increasing every year while the subsidy too is increasing every year. We are making an all-out effort to help the villager to transplant his paddy, to harrow his field, to use pure-line seed and to carry out the other cultural practices which tend to give higher yields. The Japanese method of cultivation is liked very much. We have sent 3 officers to Japan who should be back here by the end of this year, having learned the Japanese methods of cultivation. I intend to direct a special officer to be in charge of it in the Agricultural Department and to go to our farms and to introduce the Japanese method of cultivation wherever it is suitable. In some of our farms they are trying out the Japanese method. Some private cultivators are also trying the Japanese method. It has resulted in a large yield. India has gone very far in that method and from the reports we are satisfied that the Japanese method does produce high yields and is spreading throughout India.

Another method I am introducing is to make the cultivation of paddy something which our cultivator and peasant need not

be ashamed of. 30 or 40 years ago Ceylon rice was not used in some of our homes. Even the servants did not consume it. Today, Sinhala hal is popular. Some years ago agriculture was neglected, but after the late Rt. Hon. D. S. Senanayake took over the Portfolio of Agriculture, people became interested in it. Today, you find that as a result of our system of education in some of the schools children are uninterested in the profession of their parents ; they do not step into the paddy field ; they do not wear the span cloth ; they do not like mud on their bodies. I have therefore requested from the highest dignitary of the land, the Governor-General, the Prime Minister, Ministers, Members of Parliament, Chairmen of Local Bodies, high Government officials, the Vice-Chancellor of the University and members of the C. A. P. & S. Societies, to step into the field. In your village, in your own paddy field, start the paddy ceremony known as the "wap magula". The "wap magula" is an ancient ceremony. Paddy cultivation was the basis of our civilization. As Mr. Godamune would know, no cultivator would step into the field without this ceremonial function. We have relegated paddy cultivation to the backwaters, something which a man half naked alone does. Let us all help cultivators by taking part in those practices ourselves wherever they are, and I feel that it would have some psychological effect in making our people take to paddy cultivation as an art, as a noble profession more than in the recent past.

Then again we are organising possibly the biggest exhibition, an Agricultural Exhibition, to be held in Ceylon in December next year. Competitions will be organised throughout the Island for the best farm, paddy field, dairy, garden, orchard, etc. I want the whole Island to concentrate during the next 15 months on agriculture, from the peasant right up to the Prime Minister and the Governor-General with all officers co-operating so that the exhibition would show the results of our labours and we will have higher and better yields. Her Majesty the Queen has very kindly consented to be the Patron of this Exhibition and we have the right therefore to call it, for the first time, the Royal Agricultural Exhibition of Ceylon, which will be held at the Race Course. And I am asking members of the Central Board of Agriculture today, if you can help us in any way you like by forming committees or some organisation to co-operate with us.

Another method we have adopted is the Tree Planting Ceremony which we are organising in October. We have chosen October because the whole Island can take part in tree planting during that season as the wet zone and the dry zone can both be included. I want that to be Island-wide. In India it has been tried for the last 3 years. We call it the "Vana Mahothswaya". We want it to go down to the smallest village, the schools and Government Institutions. Let us each plant a tree. It must bear some fruit and that fruit must be of use. Ministers and others should take an interest in work which the humble peasant does in planting a tree. There is no use in discussing in the heart of Colombo 7 what should be done or what should not be done. The work must bear fruit in the field, in the peasant's land, and to do that we must associate with him. With regard to paddy cultivation, therefore, I should like to assure members of the Central Board of Agriculture that it is my prime concern ; my heart is with the peasant ; we have to help him. That is why we organised the guaranteed price scheme. We have been caught this year by surprise. We never expected that 30,000 tons of rice will come into our granaries. Last year the crop was less than a quarter of that yield. The Ministry of Agriculture has been asking the Treasury for go-downs for Stores, but I must admit that as Minister of Finance I refused to provide the money. Now I have asked the Minister of Finance, Sir Oliver Goonetilleke, and the last act he did before leaving that office was to allow Rs. 5 million for the establishment of these Stores ; we are trying to build them, if possible, within the next 12 months.

One reason why there has been some breakdown in the purchase of paddy under the Guaranteed Price Scheme is the lack of Stores. The second reason is the excess amount of rice we obtain under the Chinese and Burmese contracts from abroad. Next year, in 1955, we are seeking to reduce our imports by 100,000 tons, so that there would not probably be the same pressure of foreign

rice. We are hoping to have a good harvest next year too. Therefore the Guaranteed Price Scheme must work efficiently. I want every peasant who has even a bushel to sell to be able to sell it under the Guaranteed Price Scheme. We have set up a voluntary organisation, the Co-operative Agricultural Produce & Sales Societies, but they have not come to the mark expected of them. I was wondering whether Headmen could not be used as a parallel organisation so that the villager can go up to the Headman and say —"I have a bushel of paddy, can you buy ?" But reports from District Agricultural Committees seem to indicate that they do not like to entrust Headmen with the purchase of paddy. It may be a misunderstanding because the District Agricultural Committees are thinking of the conduct of some headmen during the compulsory Purchase Scheme. But this is a voluntary purchase scheme. I should like to know what the Central Board of Agriculture has to say with regard to how we can perfect the Guaranteed Price Scheme in the next harvest. We cannot set up C. A. P. & S. Societies everywhere. In surplus areas the C. A. P. & S. Societies function well. In Jaffna there is a surplus of onions, and the C. A. P. & S. Societies are confining themselves to onions. In the Southern Province there is a surplus of paddy and the C. A. P. & S. Societies should function well. If they are not functioning well, it is due to the fault of the members themselves, just as much as it is the fault of the members that the Co-operative Stores Movement failed. If the C. A. P. & S. Societies want money, I can give them the money they want. A deputation from the Eastern Province saw me and everything they wanted was done. Originally we did not want to buy from private millers, but a deputation that saw me stated that they were buying rice at Rs. 12 a bushel. They said that they could not buy rice because it was more profitable to sell to C. A. P. & S. Societies. Hundreds and thousands of people are employed by these millers ; the mills will have to close down and they will lose their jobs. The deputation of millers, consisting of Members of Parliament and others responsible, said that rice should be bought from millers. I had to buy from millers in order to save the milling industry. We are trying to have a coalition between private millers and C. A. P. & S. Societies. All this will depend on the goodness or sense of patriotism of the people who work them. Government officials are very honest men ; so are the men who function in the field. But the private citizen also must have a sense of honesty and patriotism. How can it be done ? I shall be grateful for the views of the Central Board of Agriculture.

I have read through your entire discussions and I agree with everything that has been said. From those discussions no new policy has been evolved, nor has any new plan emerged. If there is anything you can say I would be very glad to hear them.

In regard to animal husbandry, again, we are setting out into new fields. Animal husbandry can, I feel, be really improved when there is an economic return for the animals that you keep. However much you may try to improve your breed, however high the yield of milk produced by your cattle, it would be useless if you cannot sell that milk. Nobody likes to keep expensive cows or produce expensive breeds if they cannot sell the milk they produce. The question was to see that the milk produced was properly distributed. A Milk Board has been recommended for several years but not implemented. I am glad to say that the Milk Board, two members of which are here, is functioning very well from reports I hear. Very soon we may be able to implement a scheme whereby at least the surrounding dairies or new dairies, or by the removal of cattle from Colombo to the Government dairies at Welisara and Narahenpita, will be able to supply Colombo, at least a section, with an adequate, pure and good supply of milk at a reasonable price. When that happens, existing dairy owners would like to see that their dairies, that their cattle, produce more and more milk. New dairy owners will function because they will find their dairies a source of income. Like that, gradually not only in Colombo but on the estates as well—and I hope within the next few days when I go upcountry to see some of the cattle on these estates—we hope to produce within 3 months about 3,000 pints of milk a day. If we can buy all that milk, if we can guarantee a

price for milk as we have done for paddy—and nothing has induced cultivators to produce this paddy and to adopt better cultural methods than the Guaranteed Price Scheme for paddy, relieving the dairymen's mind from the problem of distribution of milk, then he will spend all his time in the production of milk.

Other methods for animal husbandry are breeding a better type of cattle, by trying to have a certain type of Sinhala cattle and with the help of the Agricultural Advisory Board let us see whether we cannot get together and work out the Milk Board and plan out a ten-year scheme for the development of animal husbandry in Ceylon.

Small countries, like Denmark and New Zealand, depend practically entirely on animal husbandry for the national income. Denmark, which is one-third the size of Ceylon, from animal husbandry alone secures its national income which is twice the national income we get from tea, rubber and coconut. Why cannot Ceylon which has a varied climate and good pasture do the same? We are now cultivating a new type of grass "Brachcharia Brizantha". Why cannot we in this country make animal husbandry the fourth living industry in Ceylon comparable to tea, rubber and coconut.

Then there are the minor products. I am very glad of Mr. P. H. C. de Silva's idea for the creation of a Minor Products Advisory Board. Take for instance Cocoa. The finest Cocoa in the world, they say, is produced in Ceylon. We must devetlop it. Coffee: Ceylon was the greatest coffee producing country in the world. Cotton, citronella and other minor products, such as, pepper and gingelly, some of them coming under the Guaranteed Price Scheme. Those must be looked after and cherished because the small man lives on them. These are some of the points I wanted to talk to you about and I am glad I had the opportunity of speaking to you even for a few minutes.

I wish that after you have read my speech on the 2nd Reading of the Budget in the "Tropical Agriculturist" we can arrange for another meeting where we can discuss these matters at great length, possibly a whole day's discussion. I will, myself, outline some of the subjects I would like to discuss so that you can come prepared to discuss more fully.

I would like first to discuss mechanization problems of Ceylon. that is something new. I have set up a Mechanization Advisory Committee. We have in Ceylon today 400 to 500 tractors. Whether they are performing their work well, whether they are of no use in Ceylon, whether they are to continue, what changes are necessary, all those problems are now before us. In the same way s we have been thinking of paddy production for the last so many years, and now that our views are being crystalised, we need to think afresh on the mechanization of agriculture in Ceylon. It is a very important problem from many points of view. Not only is the human problem becoming difficult as far as labour is concerned, but our education system is not the same. We have to think of our future generations. They need a new type of agriculture, the type that is prevailing in America and Australia—tractor farming. They would like to feel that they are technicians rather than peasants of the field in span cloth. Therefore, mechanized agriculture has come to stay and must be considered in that light. Today you are having a shortage of buffaloes. How can you remedy that? If a tractor can do the work, the peasant may not need buffaloes. All those problems are connected with the problem of mechanization. You have appointed 2 or 3 members to advise on mechanization. I trust that they will be able to be of some service.

In the light of the new developments in agriculture a point raised by Mr. Armstrong, I have requested the Agriculture Department to consider and discuss with officials whether we should not divide the Agriculture Department into two sections—an Agricultural Research Division and an Agriculture and Food Production Division. The Agricultural Research Division will concentrate entirely on the research side of agriculture. We have research men now in the Agriculture Department doing great service and we have to consider whether they should not from the beginning to the end devote their time entirely to research work. The application of that research to the field extension work will devolve entirely to

the purview of the Agriculture and Food Production Department. That is an idea I had in mind which I have asked the Director of Agriculture and his officers to consider. It is not yet policy of the Government, but it is something we must look forward to and consider in all its aspects. No hurried decisions will be taken, but I think that in some countries too this division has taken place. It is a natural division which may have to take place in Ceylon if you think it is necessary.

These are some of the problems that face me as Minister of Agriculture and Food. I am glad you have discussed these matters so frankly. I hope that when we meet again we may have a more comprehensive plan for the welfare of the people at large ".

Chairman—" Before the Hon. Minister leaves us I would like to thank him once again on behalf of all the members for having come here and addressed us today. He has invited us to spend a whole day, if necessary, to discuss carefully certain problems which he himself would put up for our deliberation.

I thank you, Sir, once again ".

VIII—Mobile Veterinary Aid

Chairman—" Mr. Morford will now address the meeting on his resolution dealing with Mobile Veterniary Aid. "

Mr. K. Morford—

" I rise to move the following resolution :

> ' That the time has come when Veterinary Aid should be brought to the villages, farms, estates and other concentrations of cattle, by scheduled visits at regular intervals of Mobile Veterinary Dispensaries. '

Now, the Honourable Minister is very keen on making the Milk Marketing Board a success, and there is going to be a big measure of support for it, but I submit that if the full realisation of his wishes is to take place, we must first of all see that there is a proper veterinary service available to every village in the Island. This can only be done by regular visits of trained personnel in Mobile Veterinary Dispensaries.

The Island is infested today with scrub cattle of definite loss to the Island and to the owners, they produce no milk, they eat needed fodder, they erode the hill sides, and they don't even drop sufficient dung to replace the food they eat. If we are to get more milk, better cattle, and a true T. T. outlook on cattle breeding, then I say, security for the owner can only be assured if he knows that the expert is literally at his door-step.

What is the position today. We have a very fine body of Veterinary Surgeons. I know many of them. But they are stationed in centres too far apart, with far too much to do. What we want is a visit every week, by Mobile men, and not merely a visit when sent for on the outbreak of a disease, and that visit probably several days after the outbreak. If this Milk Scheme is to be a success, it can not risk the outbreaks of Foot and Mouth and other diseases that from time to time hold up all milk production and sales in the producing areas.

Perhaps unwittingly, the Minister is doing one of the best steps to help the Milk Producer by removing the dairies in Colombo to proper centres outside, where the cattle can live in healthy sanitary surroundings. I hope that this will stop the regrettable trade of cows in milk being brought to Colombo from outstations, milked dry, and then returned to out-stations,, dry, ill, and with a year passed when they should have been put to the bull and be in calf again. It is these " returned empties " which bring nearly all the diseases to the up-country areas. Look at the cattle outside Hatton or Talawakele being sold on any Sunday morning. That must be stopped and it is only Mobile Veterinarians who can do this.

I say that there is a fortune for the cattle owner if he is properly advised, and can feel that he has a guru behind him always, but no villager will take readily to upbreeding his stock unless he has advice constantly available, and not merely spasmodically in the form of an occasional cattle show. It has been said that the villager will not use

fresh milk. From my own knowledge I can say that he definitely will if it is available, but that is a later stage, what we want now is to educate him to produce it, and to realise that while producing compost for his land he can also produce milk which will give him a regular income.

You will not get villagers to support a stud bull for the benefit of a few individuals, but if there is a Veterinary Officer visiting regularly, then the Stud problem becomes simplified at once, and matters can be satisfactorily regularised, as well as the control of non-approved bulls and bull calves.

In talking of cattle I have been reminded, too, of the vital parts buffaloes play in all these matters.

I am also aware that poultry farming could be run conjointly with milk production, but the heavy tax of disease, especially poultry plague is causing heavy loss. True there is inoculation, but when is this done? Surely if we have the Mobile Dispensaries then it will become routine, and poultry breeding will take its right place as a source of income.

I need not say more. There is a grand future for cattle, for poultry, for animal husbandry, but let us put the horse first, and see that every Villager knows its Veterinary Officer personally and in his village, by providing a first class Mobile Veterinary Service.

I shall conclude by relating two incidents from my own experience. Once a very mean man asked me to dine with him, much to my surprise. However, shortly before I was to start off for the dinner, he rang up saying "It's all right, you needn't come to dinner, the hen I thought was dying has recovered, so we shan't need to kill it." The second one: I suggested to some villagers that I should get a really good stud bull to help them improve their cattle—'no, no; they said, if you do that our cattle will require more food, and what shall we do then?'"

Mr. R. H. Spencer Schrader—"I do not think there is anyone who will attempt to dispute the fact that the health of cattle is the first essential in any sound scheme of animal husbandry, and the only person who can ensure good health is the Veterinarian. It is, therefore, of vital imporatnce that our Veterinary Service should be adequate to meet all demands made on it.

I am glad to say that the recently constituted Milk Board has realised that the health and well-being of the cattle producing milk are the chief considerations in any scheme for the collection of milk. It has, therefore, been proposed that a qualified Veterinary Surgeon be employed on the staff of every Milk Centre established by the Board. This will ensure that the milk supplied through the Board will come from healthy cows.

It is, of course, not intended that this step should relieve Government of the responsibility of maintaining an adequate Veterinary Service which, if it is to function properly, must be extremely mobile. It is most unfortunate that, as a measure of economy, the travelling vote has been reduced to a minimum. Outbreaks of disease amongst cattle require immediate attention, and it would be false economy to permit sickness to remain unattended purely because the small monthly quota allowed for travelling has been expended. It would be futile to expect animals to maintain good health and postpone falling ill until the Vet. is able to travel without finding himself out of pocket!

Attending to the sick is only a part of the duties of the Veterinarian. It is a truism that prevention is better than cure, and if disease is to be prevented, then there must be an enormous amount of research. Foot and Mouth disease and the Tick-borne Fevers are enzootic in Ceylon, to name the two that cause most loss. In the case of the former, it used to be the responsibility of the Veterinary Department to advertise outbreaks in the Press, and cattle owners were able to take timely precautions against infection. In recent years this responsibility was passed over to the Revenue Officers, and no notification of any outbreak is ever made. May I suggest that the Department of Agriculture resume the responsibility? Since the disease is so prevalent in Ceylon, there is unequalled scope for research. May I also suggest that the Veterinary Department devote a great deal of time to this?

The Tick-borne fevers are a fairly large group; Piroplasmosis and Anaplasmosis are two of the commonest here. It is only when an adult animal falls ill that steps are taken to cure the individual; it passes un-noticed amongst the young stock. It is generally accepted that the local and Indian cattle are fully resistant to these fevers, but we do not know whether this resistance is a hereditary factor which is very unlikely, or due to premunition, which is far more likely. It is extremely possible that the heavy mortality among calves and poor development are due to this group of diseases, and research is required very badly. Faulkner and Brown, in their report on "The Improvement of Livestock in British Colonial Territories in Africa", refer to the high mortality rate amongst calves of purely African breeds, and have pointed out the enormous improvement that has taken place as a result of Dipping Schemes for the control of ticks.

I know that there are a number of dipping tanks on Government Farms, but I believe only very few, if any, are in use! But dipping tanks are impossible for the small owner of cattle, and I am glad to say that here again, the Milk Board is doing something about the control of ticks. We have enlisted the aid of the British Ceylon Corporation to prepare, with Cooper's Cattle Dip and Coconut Oil, something for the control of ticks that will be available to the smallest owner at very small cost.

Again, we know very little about the diseases caused by deficiencies of vitamins, and minor and trace elements. It is probable that the difficulty in getting cows into calf experienced with good dairy cows is due to some deficiency in the diet. It is very likely that the poor development so marked in our local cattle is also due to some deficiencies. If improvement in our stock is to be achieved, then we must have research on these problems.

All these and many others are matters for the Veterinarian, and if there is to be any improvement in our livestock and any increase in the milk supply, it is of fundamental importance that they be tackled. The men we have in the Government Veterinary Service are a first-rate lot, but we want many more of them. In this connection, there is an anomaly that I should wish to submit to the Minister, because, I feel sure it will be agreed it should not exist. The Veterinarian is highly qualified and his course of studies extends over a period of five years; the medical course is the same; the course in dentistry covers only four years. And yet, of the three, it is the Veterinarian who is on the lowest salary scale. When it is appreciated that the health of our farm animals is vital to the health of the human population, I am confident that steps will be taken to remove this anomaly."

Dr. P. G. Malkani, Acting Deputy Director, Animal Husbandry—"I am thankful to Mr. Morford and Mr. Spencer Schrader for the very useful observations they have made. In fact when I first came to the Island in 1946 I was asked to estimate the requirements in Veterinary Surgeons for the whole Island. I estimated 200 Veterinary Surgeons for the Island. At that time I realised that it was not practicable, but I hoped that it would be realised that with the increase in the number of cattle the war against disease would also increase. I must admit that at present we have very few Veterinary Surgeons to go round. We have been alive to this and year by year the Department has been enrolling Veterinary Surgeons to meet the shortage. Now the University too is turning out Veterinary Surgeons, and am happy to say that more Veterinary Surgeons are being employed in the Department and I hope that very soon my dream of 200 will come true.

As a matter of fact we have been thinking of establishing Mobile Veterinary Dispensaries and a proposal has been made to the Ministry for 3 Veterinary Mobile Dispensaries. I am, therefore, glad that this resolution has been brought up and trust it will have the support of the Central Board of Agriculture. The capital expenditure for these mobile units will be about Rs. 55,000, but the annual recurrent expenditure is estimated to be about Rs. 4,300.

It must be emphasised that the Government will not be able to give all the Veterinary Services required. Mr. Spencer Schrader has given us good information that the Milk Board is considering the employment of more Veterinary Surgeons. As

regards the travelling allocation, it is rather a difficult question—it will have to be solved by the narrowing down of ranges. At present they are very wide. Neither can the purse of the Government be elastic enough. Thus the best thing to do is to get more Veterinary Surgeons and narrow their ranges.

I have had reports of Planters not being able to contact Veterinary Surgeons. I have referred this question to the Director and a decision would be made as to whether these Veterinary Surgeons should be provided with telephones. As regards Veterinary facilities in the field, you are now aware of several Dispensaries that have been opened. At present there are about 10 Dispensaries and it is hoped to open more.

As regards notification in the press, some time back when I was acting for Dr. Mahamooth the same question came up and it was decided that it should go to the press. I do not know what happened since, but I will look into the matter.

As regards tick-borne disease, this was a serious thing when imported cattle came here. Now I think it has been practically conquered. We are adopting immunization techniques on animals on our farms which have shown good results.

As regards that statement on dipping tanks on farms, I am afraid I cannot agree with Mr. Spencer Schrader. Perhaps Mr. Spencer Schrader has seen some, but I must state that wherever they are, dipping is a very regular feature on our farms.

It is true that at one stage even in England and the U. S. the Veterinary Surgeon was not paid his due. Times have changed now, and there are instances where Veterinary Surgeons earn even more than medical men. I am sure that with increased appreciation our problems could be solved."

Chairman—" I think there is no opposition to the proposals on Veterinary Aid so ably moved by Mr. Morford and seconded equally ably by Mr. Spencer Schrader. I can assure members that Government will consider the matter very favourably in the light of the financial situation. I shall do my best to see that Mobile Veterinary Dispensaries are provided. "

Conclusion

Chairman—" I think all of us need a rest after concentrated attention and discussion during these three hours. The rest of the items will be discussed at the next meeting. After this meeting we could ask the Hon. Minister to come over and discuss the various problems with members.

In the meantime I shall try to get these Sub-Committees to meet and formulate the work to be done. "

Mr. Gladwin Kotalawala—" I would suggest that Visitors Books be kept at all the Farms so that members of the Central Board of Agriculture could note down their comments. "

Chairman—" I would like to consider the matter. "

7th meeting.

Mr. Gladwin Kotalawala—This is the 7th meeting. I would like to see at the next meeting a summary of resolutions which have been implemented up to date. "

The meeting terminated at 6.30 p.m.

A. J. Joseph,
Secretary,
Central Board of Agriculture.

Peradeniya, December 8, 1954.

ANIMAL DISEASES RETURN
July-September, 1954

Province	Disease	Fresh Cases during the Quarter	Total Number to end of Third Quarter, 1954				Balance ill at end of the Quarter
			Cases	Deaths	Shot	Recoveries	
Western Province (excluding Colombo Municipal area)	Rabies	91	238	—	238	—	—
	Foot-and-mouth	405	1,279	19	—	1,163	97
Northern Province	Anthrax	229	291	291	—	—	—
	Rabies	9	19	—	19	—	—
	Black Quarter	1	117	117	—	—	—
North-Central Province	Foot-and-mouth	74	986	10	—	906	70
	Rabies	—	2	—	2	—	—
	Black Quarter	291	441	441	—	—	—
North-Western Province	Rabies	8	17	—	17	—	—
	Foot-and-mouth	432	530	31	—	489	10
Central Province	Rabies	17	49	—	49	—	—
	Piroplasmosis	—	5	—	—	5	—
	Foot-and-mouth	67	95	—	—	45	50
Province of Sabaragamuwa	Rabies	1	10	—	10	—	—
	Foot-and-mouth	148	148	1	—	147	—
	Black Quarter	3	3	3	—	—	—
Province of Uva	Rabies	2	6	—	6	—	—
	Foot-and-mouth	12	12	—	—	12	—
	Black Quarter	14	14	11	—	3	—
Eastern Province	Foot-and-mouth	6,219	9,187	622	19	8,155	391
	Mange	—	171	40	—	131	—
	Rabies	2	2	—	2	—	—
	Black Quarter	36	36	36	—	—	—
Southern Province	Rabies	5	20	—	20	—	—
	Bovine Farcy	—	12	1	—	11	—
	Black Quarter	86	86	86	—	—	—

Department of Agriculture,
Peradeniya, December 3, 1954.

M. Z. MAHAMOOTH,
Deputy Director (Animal Husbandry) and Government Vaterinary Surgeon.

METEOROLOGICAL REPORT
July-September, 1954

SUMMARY

THE rainfall in July was appreciably below normal in the south-western hill country, where the monthly receipts were below expectations by 5 to 10 inches. Elsewhere in the south-western parts the deficits ranged from 2 to 5 inches. Outside the south-west quarter the rainfall did not deviate much from average, but there too deficits predominated. The greatest monthly totals occurred on the south-western slopes of the hills, where the aggregates at several stations exceeded 15 inches. From this region there was a rapid decrease in rainfall, monthly totals at the south-western coast stations being less than 5 inches. Outside the south-west quarter the rainfall was chiefly below 2 inches. About 15 stations did not receive any rain. Ordinary monsoon weather prevailed generally, with light to moderate south-westerly winds and occasional rain in the windward regions. Monsoon conditions became active on the 5th, resulting in heavy rain accompanied by strong south-westerly squalls in the western and south-western parts. Strong winds caused considerable damage to house and property in Puttalam area. There was moderately heavy rain in the south-west on the 17th too. A low pressure wave in the Bay of Bengal was responsible for the rain which occurred in the North-Central Province and neighbourhood on the 24th. A hail storm was reported from the Haputale hills on the 1st.

Active monsoon weather prevailed in the south-western hill-country during August. Rainfall was experienced almost daily, several stations recording monthly totals over 25 inches. From this region there was a rapid decrease in rainfall, monthly totals at the south-western coastal stations ranging from 5 to 10 inches only. Outside the south-west quarter the rainfall was below 5 inches, except in the northern half of the North Central Province, where it ranged from 5 to 10 inches. The rainfall was least (below 2 inches) in the North Western Province, in Batticaloa District and in the south-eastern low-country. In the south-western hill-country the rainfall was considerably above normal, excesses at several stations exceeding 10 inches. Appreciable excesses were also found in the northern parts of the North Central Province. Deficits, generally small, occurred in the northern half of the North-Western Province and in parts of Badulla and Batticaloa Districts. In the south-western parts the rainfall was moderately heavy on the 1st, 5th and 30th. Rainfall in the North-Central Province and neighbourhood occurred on the 11th, 12th, 22nd and 27th, as evening thundershowers. The 8th was a dry day for the whole Island.

The rainfall in September was below normal practically throughout the Island. Bigger deficits (of the order of 5 to 10 inches) occurred inland in the south-western regions. Over a greater part of the rest of the Island the deficits ranged from 2 to 5 inches. A few slight excesses were found in Pottuvil area of the Batticaloa District. The larger monthly totals occurred inland in the south-west quarter, but they ranged mainly from 5 to 10 inches only. Outside the south-western regions the monthly rainfall was mainly below 2 inches. Many stations in the Northern and North-Central Provinces recorded no rain at all, the number of nil reports exceeding 80. South-west monsoon weather prevailed generally during the month, but the winds were mainly dry. The only day on which the rainfall in this region was appreciably heavy and widespread was the 22nd. Owing to weak monsoon conditions, evening thundershowers were experienced in the north and the east from the 10th to 12th.

D. T. E. DASSANAYAKE,
Director.

Station	July									August			
	Temperature				Humidity		Rainfall			Temperature			
	Mean Maximum	Offset	Mean Maximum	Offset	Day	Night (from Minimum)	Total	Offset	No. of Days	Mean Maximum	Offset	Mean Minimum	Offset
Anuradhapura ..	89·7	—1·2	74·7	—1·2	67	90	1·99	+0·67	4	91·0	—0·5	74·8	—0·8
Badulla	87·0	+0·8	65·4	+1·2	61	92	0·67	—1·50	6	85·6	—0·5	66·7	+2·3
Batticaloa.. ..	90·1	—1·9	76·1	—0·9	72	88	1·30	+0·26	6	90·0	—0·6	76·9	+0·4
Colombo	84·4	—0·4	76·4	—0·5	78	86	3·33	—2·16	7	83·6	—1·3	76·4	—0·6
Diyatalawa ..	77·9	0	62·6	0	63	81	1·24	—0·72	8	77·3	—0·6	62·2	+0·5
Galle	82·4	—0·3	76·8	+0·1	84	88	3·69	—2·65	12	82·1	—0·6	76·4	—0·3
Hambantota ..	86·6	—0·8	76·1	—0·2	78	88	4·53	+2·52	9	85·9	—1·1	75·6	—0·5
Jaffna	85·7	—0·4	79·4	—0·4	78	85	1·80	+1·25	3	86·4	+0·3	79·1	—0·2
Kandy	81·6	—	69·4	—	71	87	4·47	—	17	80·7	—	69·7	—
Kankesanturai ..	89·4	—	79·3	—	70	85	1·14	+0·60	4	90·4	—	79·0	—
Kurunegala ..	86·4	+0·1	75·0	—0·2	72	88	4·60	+0·72	14	85·8	—1·1	74·9	0
Mannar	87·0	—0·4	78·9	—0·3	76	84	0·34	—0·01	2	87·5	+0·1	78·7	0
Nuwara Eliya ..	65·7	+0·5	55·8	+0·9	79	85	6·30	—4·72	20	64·8	—1·3	55·3	+1·0
Puttalam	86·9	+0·9	77·6	—0·7	74	86	1·62	—0·63	4	88·0	+1·6	77·8	—0·2
Ratmalana ..	85·1	—	77·5	—	74	82	4·43	—1·03	9	84·6	—	77·3	—
Ratnapura.. ..	87·9	+1·4	74·3	—0·1	77	93	5·83	—6·94	16	85·9	—0·9	74·0	—0·3
Talawakele ..	71·5	+1·3	59·2	—0·3	85	94	8·48	—4·82	21	69·1	—2·0	59·7	+0·5
Trincomalee ..	91·7	—0·7	77·7	—0·3	63	80	1·35	—0·38	4	91·2	—1·0	76·6	—0·7
Maha Illuppallama ..	88·7	—	74·9	—	66	86	2·22	+0·79	5	90·3	—	75·2	—

Station	August (contd.)					September							
	Humidity		Rainfall			Temperature				Humidity		Rainfall	
	Day	Night (from Minimum	Total	Offset	No. of Days	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum	Total	Offset	No. of days
Anuradhapura ..	66	88	2·81	+1·19	6	93·0	+1·2	74·8	—0·3	58	88	0·18	—3·58	2
Badulla ..	67	92	2·83	—1·37	9	86·2	+0·5	63·4	0·9	60	86	1·37	—3·12	4
Batticaloa ..	68	84	0·97	—0·98	6	91·6	+1·8	77·2	+1·0	66	80	0·07	—2·32	4
Colombo ..	82	88	5·74	+1·71	12	84·6	—1·8	75·8	—0·9	79	91	4·05	—2·79	14
Diyatalawa ..	72	86	5·73	+2·61	19	77·9	+0·1	60·9	0	62	83	1·83	—2·58	5
Galle ..	85	88	5·35	—0·79	23	82·4	—0·5	76·3	—0·5	84	88	6·68	—2·13	17
Hambantota ..	78	88	2·83	+1·39	8	86·3	—0·3	75·8	—0·4	78	88	0·52	—2·22	9
Jaffna ..	78	82	3·13	+2·02	5	85·6	—0·7	79·2	—0·1	78	85	0	—2·53	0
Kandy ..	76	87	8·68	—	23	82·3	—	69·0	—	69	87	1·09	—	13
Kankesanturai ..	70	85	3·25	+1·99	5	89·6	—	79·4	—	69	80	0·40	—2·57	3
Kurunegala ..	76	88	5·43	+1·81	17	87·8	+0·2	74·8	+0·5	67	88	1·65	—3·90	9
Mannar ..	76	86	0·80	+0·14	4	87·3	—0·4	79·3	+0·5	77	87	0	—1·24	0
Nuwara Eliya ..	87	91	13·97	+6·46	28	66·4	—0·4	54·3	+1·1	88	85	2·74	—5·50	16
Puttalam ..	72	84	0·49	—0·16	4	88·5	—1·6	78·0	+0·1	68	84	0·03	—1·55	1
Ratmalana ..	76	82	5·95	+2·47	14	85·7	—	76·8	—	72	86	3·10	—3·74	17
Ratnapura ..	81	95	15·02	+3·63	26	88·2	+1·0	73·7	+0·2	73	95	6·82	—7·70	15
Talawakele ..	90	97	14·66	+4·58	28	71·2	—1·1	58·8	+0·5	84	94	5·09	—4·66	19
Trincomalee ..	66	82	5·43	+1·82	10	93·0	+0·9	77·5	+0·4	60	78	2·85	—0·58	3
Maha Illuppallama	64	84	1·68	+0·07	4	92·8	—	75·4	—	65	84	0	—3·05	0

Tropical Agriculturist

Agricultural Journal of Ceylon

Vol. CXI, 1955

Published by
The Department of Agriculture,
Ceylon.

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TROPICAL AGRICULTURIST

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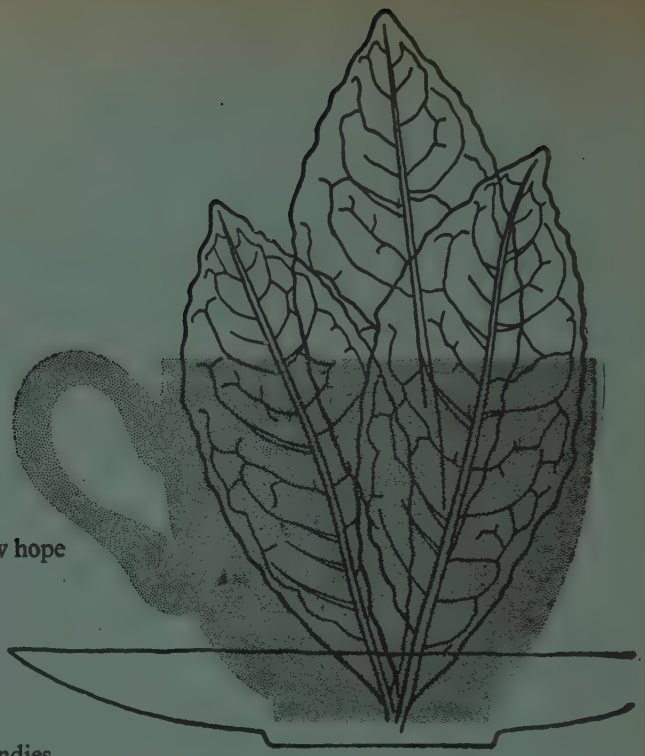
DEPARTMENT OF AGRICULTURE
CEYLON

VOLUME CXI
NUMBER I
JANUARY TO MARCH, 1955



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TROPICAL AGRICULTURIST

Volume III January - March, 1955 Number I

Published Quarterly By

DEPARTMENT OF AGRICULTURE
PERADENIYA, CEYLON

Subscription Rates

(Inclusive of Postage)

	Annual	Single copy
Local	Rs. 5·00	1·50
India, Burma and Pakistan	Rs. 6·50	2·00
Abroad	Rs. 8·00	2·50

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Back Cover	Rs. 40·00	50·00
Inside Back	Rs. 35·00	40·00
Inside Front	Rs. 35·00	40·00

All correspondence and payments should be addressed to AGRICULTURAL OFFICER (PUBLICITY), DEPARTMENT OF AGRICULTURE, PERADENIYA, CEYLON.

Registered as a newspaper in Ceylon.

NOTE TO CONTRIBUTORS

(1) Manuscripts for publication should be typewritten on one side of the paper at double spacing and sent in duplicate to the *Editor, Tropical Agriculturist, Department of Agriculture, Peradeniya, Ceylon.*

(2) Articles should be divided into sections, each headed by a caption, and concluded with a brief summary, if necessary.

(3) Text figures and photographs must be (*a*) suitable for reproduction, (*b*) supplied with legends typed on separate sheets of paper, and (*c*) separate from the text but allocated to sections of the text.

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EDITORIAL

Horticultural Development in the Island

THE CULTIVATION of economic varieties of fruits in the Island may be said to date from the early days of the Royal Botanic Gardens and of the Ceylon Agricultural Society. A large number of economic fruit trees, e.g., durian, cherimoyer, avocado pear, tree tomato and temperate fruits suited to upcountry areas were introduced into the Island at that period, but no systematic trials were conducted in horticultural problems until the creation of a Division of Horticulture in 1941 following on the recommendations of a Committee appointed by Government to report on the development of the fruit industry in the Island in 1938. It should be stated, however, that some experimental work had been done in the years immediately preceding this development on the vegetative propagation of citrus and mango.

Since the establishment of the Horticultural Division a considerable amount of work has been carried out on the selection of outstanding mother trees of varieties of fruit for supply of clonal budwood, the development of suitable root stocks, stock-scion relationship and improvements in bud-grafting technique. As a result of these studies selections of a high standard of different types of fruit were made, notable among them being the Seedless Bibile sweet orange, which is believed to have originated as a bud sport of the Bibile Sweet orange, and the Omantai mandarin which is not unlike the famous Nagpur Santara. Of recent introductions which have proved a success the following may be mentioned: *neelam* mango, Pollock avocado, Malayan rambutan, Gros Michael banana, the seedless guava, the mammoth sapodilla and the Hawaian solo papaw.

Despite a ready market for good fruits in the Island and the availability of information on their successful cultivation as a result of the investigational work undertaken, there has been comparatively little development in the commercial production of fruits except in regard to plantains which are cultivated fairly extensively in many parts of the Island. Of other fruits which are cultivated on a commercial scale in localised areas mention should be made of the plantain in the Neervelli area of the Jaffna Peninsula, citrus in Bibile and other areas of lower Uva, and pineapple in the Gampaha District. The Department of Agriculture has encouraged the cultivation of mangoes on a large scale and has established orchards of varying extents on its farms in the dry zone, the largest being at Hingurakgoda where 100 acres are under the crop. Mangoes of excellent quality are, however, cultivated extensively in the Jaffna Peninsula though in small holdings.

With the extension of the canning industry in the Island, there will be scope for the establishment of a number of commercial orchards under crops such as mangoes and pineapples. The Land Utilization Committee of 1952 makes reference in its report to this subject and there is little doubt that well-organised orchards of mango and citrus could be made to pay if they are run in conjunction with some animal husbandry enterprise, e.g., poultry.

The citrus industry in the Island has not met with the success which the efforts put into it have led one to anticipate. The causes for this are not yet satisfactorily unravelled, and the parlous condition of the citrus industry of lower Uva gives occasion for anxiety because it was at one time a flourishing industry. A disease of virus or fungus origin is taking its toll and the industry is fast declining. Steps, however, are now being taken to resuscitate it and the services of an expert on citrus culture with particular reference to the control of pests and diseases are being requisitioned for studying the problems involved and re-establishing the industry on its former basis. There is little doubt, however, that one cause for the decline of the industry is the scanty attention given to the crop by the cultivator. Unlike coconut which stands up to a great deal of neglect, citrus is a delicate crop and needs constant attention if it is to produce results commensurate with the cost of establishment. A point which must be stressed is the absolute importance in citrus culture of regular manuring with cattle manure for supplying the minor nutrient elements which are so essential for the healthy growth of the crop.

In order, however, to utilise the present crop to full advantage, an officer of the Department trained in Australia in Food Technology is being stationed in the citrus district to organise the growers to obtain the best returns from their produce by preservation as fruit juices and cordials or by refrigeration. It is envisaged that these measures will before long help to resuscitate an industry which has been the economic mainstay of the people of these areas in the past.

In order to make the people of the Island more fruit conscious and to impress on them the value of fruit as an article of diet, opportunity was taken of the recent Tree Planting Campaign to issue large quantities of planting material of improved varieties to interested growers all over the Island. It is hoped by this means to ensure that the public are not deprived of an essential article of food. Any "Eat more fruit" Campaign will be of little avail unless there is an adequate supply of the commodity and it should, therefore, be incumbent on every land owner to have in his own garden, however small, a few trees from which he can derive, from time to time at any rate, life-giving sustenance for himself and his family.

The scope of the work of the Horticultural Division of the Department of Agriculture has within recent years been extended to include other horticultural crops such as cacao, pepper, betel, &c., but reference to these

will be made in a separate editorial when the question of minor agricultural products is being discussed. It suffices to say, however, that fruit culture is continuing and will continue to receive the importance which a subject of this nature should warrant. Additional staff has been added to the Division and in due course further increases will be made to it. Attention has also been given to augmenting the staff concerned with the question of the control of pests and diseases as it is realised that the effective control of these and the production of resistant varieties are major factors which merit consideration in the successful rehabilitation of horticultural crops.

Errata

Tropical Agriculturist, Vol. CX, No. 2, 1954, p. 75, line 7—1922 should read 1822.

Tropical Agriculturist, Vol. CX, No. 4, 1954, p. 256, column 1, line 25—'husked' should read 'unhusked'.

A Survey of Agricultural Conditions in the North-Central Division

H. E. NANAYAKKARA

THE North-Central Division consists of two Districts, namely, the Anuradhapura District or Nuwara Kalawiya (the latter name being derived from the three large tanks Nuwarawewa, Kalawewa and Padawiya), and the Polonnaruwa District or Tamankaduwa. The Anuradhapura District has a total area of 2,808 5/8 square miles, while the Polonnaruwa District is 1,331 5/8 square miles in extent. Twenty-one-and-half miles of the former and 17 9/20 square miles of the latter consist of large inland waters. Thus, of the total area of 4,140¼ square miles or 2,649,760 acres in the two Districts, the total land area constitutes 2,624,862 acres. The extent cultivated at present is 170,032 acres comprising 6.67 per cent. of the total land area. Approximately 80 per cent. of this consists of paddy land, while land under coconuts form 1½ per cent. and the rest of the area consists of chenas, garden cultivations, &c.

Climate and Rainfall

There is a seasonal variation of temperature of about 8°F, the lowest being recorded during the months of November and December. Then there is a gradual rise through the months of February, March and April till May, when the temperature reaches a maximum and begins to drop in September to a minimum in November and December.

The rainfall too is markedly seasonal. The average monthly rainfall in various parts of the Division for the period 1943 to 1953 is given below.

Table showing Average Monthly Rainfall in the Division

	Anuradhapura District—Rainfall in inches				*Polonnaruwa District—Rainfall in inches*		
	Anuradhapura	*Medawachchiya*	*Maha-Illupallama*	*Horowpotana*	*Kahatagasdigiliya*	*Hingurakgoda*	*Topawewa*
January	3·94	5·18	4·53	7·06	5·52	8·89	10·54
February	2·23	2·17	2·23	2·36	3·74	3·98	4·85
March	3·29	2·35	3·04	1·94	2·26	4·19	4·72
April	6·45	5·91	6·95	5·54	3·45	5·73	4·48
May	2·95	3·26	3·23	5·83	3·81	3·47	2·67
June	·61	·21	·74	·16	·31	·20	·27
July	1·12	1·68	1·17	1·77	1·73	1·84	1·47
August	1·54	3·50	2·43	3·55	2·28	2·38	2·19
September	2·47	3·24	3·04	3·34	3·55	2·45	3·76
October	10·04	9·26	10·73	8·33	8·26	8·27	7·87
November	10·27	10·33	10·00	11·59	10·61	10·62	10·78
December	10·17	9·79	8·51	13·87	12·08	12·92	13·42

There is a major wet period from October to January which comprises the North-East Monsoon season followed by a relatively dry period from February to March. April is a wet month which is followed by a major dry period from May to September during which intermittent light showers do normally occur, while strong dry winds are experienced in June to July.

There have been years when the total rainfall has been as low as 25 inches resulting in acute and prolonged droughts. The frequency of their occurrence has increased in recent years.

Rural Set Up

There are in the North-Central Province over 2,000 villages some of which are uninhabited. Each village consists of the village tank (from which the village derives its name) the paddy allotment or *wel-yaya*, the housing allotment or *gangoda* with permanent fruit trees and the surrounding jungle which is periodically cleared for chena-cropping. The *gangoda* lies in close proximity to and almost immediately above the tank. This position is the most suitable one as the villagers depend on the water stored in the tank for their domestic water supply. Sometimes the tank also supplies fish.

Population and Labour

According to the 1953 Census the population of the Province is given as 229,174. The population figure for each District together with the density per square mile is given below :—

ANURADHAPURA	
Land area	2,787⅛ sq. miles
Population	171,105
Density per sq. mile	61
TAMANKADUWA	
Land area	1,214 7/40 sq. miles
Population	58,069
Density per sq. mile	47

The paucity of the population in the Province is all too clearly indicated, and is a major factor contributing to the relatively low level of agricultural development. The absence of any form of intensive cultivation, particularly in the case of highland crops can also, in the main, be attributed to the lack of manpower. Tractors and other mechanical equipment should alleviate the position considerably.

Agricultural Holdings

The total number of agricultural holdings and the cultivable extent (as given in the Census of Agriculture—1946) are given below :—

Number of holdings—169,319.

Cultivable extent—127,853 acres.

Approximately 75 per cent. of the holdings consists of paddy covering about the same proportion of land. Paddy holdings classified according to size are enumerated below (as given in the Census of Agriculture—1946).

Less than ½ acre ..	51,901	holdings
½—1 acre ..	42,066	,,
1—2 acres ..	22,029	,,
2—5 acres ..	8,660	,,
5—10 acres ..	1,629	,,
Above 10 acres ..	345	,,

Thus, 74.2 per cent. of the paddy holdings are less than one acre in extent, while only 15.6 per cent. are above 5 acres. Over 50 per cent. in the group of holdings less than 1 acre are nearer ½ acre.

Transport and Marketing

Means of transport in the rural areas of the Province leave much to be desired. In most cases the only available transport is that provided by the bullock-cart. During wet weather even this is rather uncertain. In some cases even bullock-carts are ruled out as the only available means of access is the foot path. As far as the urban areas are concerned, road and rail transport facilities can be considered fair.

The marketing of produce for which there is a guaranteed price, is done through C. A. P. & S. Societies and private traders, although the latter pay much less than the guaranteed price. As regards other produce, Marketing Department lorries call regularly on fixed dates and buy whatever produce that is brought at fixed prices.

Fairs are also held on fixed days of the week at the following centres: Rambawewa, Nochchiyagama, Tambuttegama, Eppawala, Maha Illuppallama and Sangilikanadarawa.

Irrigation

The methods of surface storage devised in ancient times form the back-bone of the irrigation system of today. There are in the Province a large number of these storage reservoirs or tanks, a few of which are capable of storing water to irrigate extents of 10,000 acres and more. The most noteworthy among them are the Kalawewa, irrigating 11,565 acres, the Prakrama Samudra, irrigating 18,000 acres, and the Huruluwewa, irrigating 10,000 acres.

There are a few more tanks which come under the category of major tanks. The names of these tanks together with the extents that could be irrigated are as follows:—

Name of Tank	*Irrigable Extent (acres)*
Minneriya	7,344
Nachchaduwa	6,067
Devahuwa	2,336
Nuwarawewa	1,505
Sangilikanadarawa	840
Giritale	786
Tissawewa	765
Basawakkulama	528
Kattiyawa	569
Maha Illuppallama	364

There are over 2,000 minor tanks scattered over the Province. Of these, 1,741 are in good order and have capacities to irrigate extents varying from 50 to 150 acres. The remaining minor tanks and a few large ones such as Maha Kanadarawa and Maha Willachchiya are awaiting restoration. Padawiya, another large tank, is being restored.

Paddy Cultivation

There are 143,673 acres of paddy land in the Province. 61,235 acres are under major tanks and 82,438 acres under minor tanks. A small extent is grown under rainfed conditions in chenas. In a normal year, about 80 per cent. of the total acreage is cultivated for the *maha* season and less during *yala*. Lack of sufficient irrigation water, shortage of buffaloes and the paucity of the population are, in the main, responsible for a large extent of paddy land being uncultivated.

There are two main planting seasons which coincide with the two rainy seasons—the *maha* during the North-East Monsoon period and the *yala* during the South-West Monsoon. Of these the *maha* is always the major season. There is a third season known as *meda* which, as the term implies, comes in between the *maha* and *yala*, and is generally preceded by a delay in the onset of the North-East Monsoon. Thus, the *meda* season takes the place of the normal *maha*. Where a *meda* crop is sown the *yala* is delayed.

Improved Methods

(i) *Light Iron Plough*. The light-iron plough can be used successfully only in areas where the soil is light and sandy. Some headway has been made in persuading cultivators to use this implement, but the problem of breaking down the barriers created by hundreds of years of tradition still exists.

(ii) *Pure-line Seed*. Roughly 25 per cent, of the cultivated acreage is under pure-line paddy. The two pure-line varieties *Vellai Illankalayan* (for *maha*) and *Pachchai Perumal* (for *yala*) are not favoured much by cultivators in the Province. These are to be eventually replaced with better pure-lines such as H. M. C. 20, *Mas* and *Murungakayan* for *maha*, and *Heenati* and *Murunga* for *yala*.

(iii) *Manuring*. The use of inorganic fertilizers is very limited, while appreciable extents are manured with cattle manure and green manure. The need for some form of manuring is keenly felt, particularly in the older paddy lands (*purana fields*), while there is no doubt that the new lands too will respond to the application of fertilizers.

(iv.) *Transplanting*. Although the benefits derived from transplanting are known to practically every farmer in the Province, efforts to extend this practice have met with very little success. The main drawback is the shortage of labour.

(v.) *Harrowing the Standing Crop*. This practice has gained ground rapidly and is a very good alternative to transplanting. However, the lack of an adequate supply of irrigation water at the time of harrowing acts as a limiting factor at times.

(vi.) *Weeding*. Weeding is by no means a widespread practice; but appreciable extents are weeded every season with the help of school children, Young Farmers' Clubs, &c.

Pests and Diseases

The common pests prevalent in the North-Central Province are the paddy fly and the paddy swarming caterpillar. The present method of control, i.e., spraying with D.D.T. or Arcotine in the

case of the swarming catepillar, and dusting with Gammexane against the paddy fly have been found to be quite adequate. Paddy cultivators are very efficient in detecting the occurrence of both these pests, but they are seldom equally efficient in the application of the remedy without the assistance of the Extension Staff.

No serious diseases have been reported, but evidence of the occurrence of *Helminthosporium oryzae* and *Curvularia lunata* has been brought to light recently. It is reasonable to assume that the effects of these two diseases may have been sufficiently reduced by environmental factors unfavourable to the progress of the disease so as to have escaped detection under normal circumstances.

Highland Cultivation

Perennial Crops. Coconuts, citrus and mangoes constitute the main perennial crops grown in the Division, while the tamarind is of frequent occurrence though not systematically cultivated.

Coconuts are found mainly in small patches near and around some of the major tanks and water courses. Citrus and mango occur in the highland allotments of colonization schemes and in the unirrigable lots near village tanks.

Miscellaneous fruit trees such as jak and arecanut are found scattered in a few villages.

Annual Crops. Annuals corps are cultivated mainly in chenas under rainfed conditions; a very small extent being grown in home gardens where rainfall is supplemented by hand-watering from wells. Encouragement towards a settled type of intensive cultivation is given by the alienation of allotments (1 to 2 acres in extent) under the L. D. O. permits.

Chena Cultivation. The clearing and burning of the jungle is done during the months of July and August, and sowing commences after the first rains which normally occur towards the latter part of September. Mixed cropping with kurakkan, mustard, maize and vegetables (among which pumpkin, brinjal and bandakka are the most popular) is the general rule. In recent years there has been a tendency to grow these crops in pure stands. Paddy is also very frequently cultivated as a chena crop whenever the weather conditions are favourable.

The extents cultivated under the various crops during the last year are given below. Practically all the crops have been grown under rainfed conditions.

Crop	*Acreage*
Kurakkan	8,420
Maize	4,682
Sorghum	2,375
Chillie	5,878
Gingelly	6,856
Bombay cowpea	1,635
Green Gram	1,077
Vegetables	5,000
Manioc	2,141

Land, Land Tenure and Capital

At present only 6.67 per cent. of the total land area in the Province is being cultivated. A much bigger percentage can be brought under cultivation by increasing the available water supply and settling more people on the land.

The restoration of the larger tanks such as Padawiya, Maha Kanadarawa and Maha Willachchiya and the numerous minor tanks should add considerably to the extent that could be brought under cultivation.

Although assistance is given by Government for the purpose of opening up and developing more land, the rate of progress is very slow. Lack of capital is keenly felt. Attempts to attract capital from other parts of the Island have so far had no response, presumably because of the very high cost of development.

Absentee land-lordism to some extent and insecurity of tenure are also responsible for retarding any possible investment even on a small scale. The main system of tenure prevailing in the Province is the so-called *ande* system wherein the lessee has to pay the landowner in kind. In some cases the latter provides the seed paddy, buffaloes for ploughing, &c., and fertilizers, and also gives cash advances to the lessee during the cultivating season. In other cases no interest is shown by the land owner except in ensuring that he gets his dues from the lessee.

A small amount of capital is made available to cultivators through C.A.P. & S. Societies. This has certainly served to ameliorate the position to some extent. In addition, financial assistance is given by Government for the purpose of constructing houses and wells on land alienated to villagers on L. D. O. permits.

Colonization Schemes

There are in the Province, a number of colonization schemes, namely, the Kagama Scheme, the Huruluwewa Scheme, Sangilikandarawa and the Dewahuwa Schemes in the Anuradhapura District, and Minneriya, Giritale and the Parakrama Samudra Schemes in the Polonnaruwa District.

Under these schemes approximately 40,000 acres of paddy land and 24,000 acres of highland have been alienated, each colonist being given 5 acres of paddy land and 3 acres of highland together with a type-plan cottage situated in the highland allotment. Each colonist pays a land rent of Rs. 10 per acre per year and a water rate of Rs. 5 per acre per year of paddy land adding up to a total of Rs. 105 per year.

All the paddy land except in the recently and partly settled Huruluwewa Scheme has been fully developed, but it is not always that the full extent is cultivated. In this respect, the schemes in the Polonnaruwa District are more fortunate as a greater percentage of paddy land is cultivated there than in those in the Anuradhapura District where mainly due to restrictions imposed by the lack of sufficient irrigation water the extent cultivated is reduced. The completion of the Nalanda Oya Scheme will tend to improve the position considerably in the latter case. Lack of an adequate number of buffaloes for ploughing and mudding operations and a shortage in man-power too limit the extent of paddy land cultivated. In some cases the colonists start by sowing a 4-month variety for *maha* and end up with a 3-month variety when he is unable to prepare all the land in

time. The use of the tractor in preparatory tillage operations can change the picture into a happier one.

The highland allotments have not been developed on the lines envisaged. Coconut seedlings and fruit trees such as mango and citrus have been given free to all colonists, but few have so far obtained the full benefits of these concessions. Plantains appear to be the most popular cash crop grown in the highland allotments and good incomes are obtained.

Dry Farming Schemes

There are two Dry Farming Schemes in the Division, one at Kurundamkulama which is situated south of the Trincomalee-Anuradhapura road and about 5 miles from the Anuradhapura town and the other at Ralapanawa, situated south of the Anuradhapura-Puttalam road about 12 miles from Anuradhapura town. The total extent of land at Ralapanawa is 667 acres while Kurundankulama occupies 1,068 acres.

In each scheme a number of colonists have been settled in much the same way as in the colonization schemes administered by the Revenue Officers.

Each colonist is provided with a house consisting of a verandah, bedroom, dining room and kitchen together with two acres of land which comprise the homestead. Here the colonist grows his permanent crops such as coconuts and fruits trees, and chillies, onions and vegetables required for his home consumption.

The homesteads are grouped into units of five each and there is a well for each unit.

Apart from the homestead each colonist is given 12 acres of highland which have to be cultivated co-operatively with the allotments of a number of other colonists, who are grouped into one unit. Only half the extent is cultivated at a time, the other half being rested—the resting period being 4 years.

The crops usually grown are kurakkan, maize, chillies, cowpea and groundnuts for the *maha* season and gingelly and greengram for the *yala*.

The profits derived by the sale of the produce are divided amongst the colonists in proportion to the quantity of work put in by each.

Soils

Physically the soils in the Province vary from sandy loams to very heavy clays. The major part of the paddy soils consist of the latter type.

The fertility of the paddy soils particularly in the so-called *purana* fields is rather low. The highland soils too lose their natural fertility very soon after the forest has been felled and the land has been cropped for two or three seasons.

A number of soil types have been recognised. First, we get the chocolate brown loam that occurs in a greater part of the Anuradhapura District. This type of soil is suitable for the cultivation of dry zone annuals, perennial crops and fruits under irrigation. Another type is the reddish-brown loam which occurs in the Habarana area. These soils have a gravelly subsoil layer which permits the rapid percolation of water with the result that a very good supply of irrigation water is necessary for the cultivation of the

usual dry zone crops. A third type is the *damana* soils of the Minneriya area. These soils are generally shallow and the underlying strata consist of partly decomposed rock that are not quite suitable for paddy, but fodder grass could be grown under irrigation.

Cattle

The majority of the cattle belong to the so-called Sinhala breed. They are generally of very poor quality due to under feeding and lack of care and management. Bulls are allowed to run with the rest of the herd thereby causing indiscriminate and promiscuous breeding. Very often the cows give birth in the jungle unknown to the owners. Only in a very few cases are the cows milked. However, cattle are a ready source of income to the owner. They are rounded up periodically and sold for slaughter. The question of feed becomes very serious during periods of prolonged drought. There is no doubt that better feeding, management and housing will bring about a marked improvement in the general standard of the cattle. Crossing with a better type of animal such as the Scindi can bring about a further improvement in quality.

As a rule buffaloes do not even get the little attention received by neat cattle. They are rounded up by the owners during periods when their services are needed for ploughing and mudding operations and threshing paddy. In between these periods they are allowed to roam at will and fend for themselves.

Poultry

Poultry keeping is also practised mainly by Muslims, but in recent years other sections of the population have also shown some interest in this direction. Most of the birds are of the country-bred type, while there is a small proportion of pure-bred types of the Rhode-Island-Red, Australorp and White Leghorn breeds. Proper feeding, housing and management are practised by only a few of the more enlightened poultry farmers.

Vegetative Propagation of Betel and Pepper Vine

A. V. RICHARDS

Received 5.4.55

Summary

BOTH betel and pepper are normally propagated from cuttings. Trials with different rooting media have shown that in the case of betel both single leaf cuttings and stem cuttings produced significantly more roots within two to three weeks in a medium of coir dust and fibre than in either sand or soil, and more shoots in soil than in sand which is relatively infertile. Stem cuttings produced more roots and shoots than single leaf cuttings in each of the four different rooting media under study.

But in the case of pepper single leaf cuttings gave better results than stem cuttings which are generally used, and both types produced more roots and shoots in coir dust and fibre than in sand or soil.

Introduction

Betel (*Piper betel*) and pepper (*Piper nigrum*) are money crops grown in Ceylon which play an important role in the village economy. Owing to the incidence of Bacterial Leaf Spot and Collar Rot diseases which are difficult to control the local production of betel leaf is likely to become inadequate to meet the demand which has increased considerably in recent years. Although fair quantities are imported from India almost daily to meet a specialised demand for certain varieties of betel there is an appreciable export trade with Aden as indicated in the following statement of imports and exports for the last five years which also shows a tendency for exports to rise.

Export and Import Trade in Betel Leaves

Year	*Imports*		*Exports*		
	Quantity in Cwt.	*Value in Rs.*	*Quantity in Cwt.*	*Value in Rs.*	*Excess of Exports over Imports in cwt.*
1950..	478	56,101	922	46,668	444
1951..	293	25,622	1,344	67,658	1,051
1952..	360	39,359	1,298	84,124	938
1953..	277	33,813	1,345	76,919	1,068
1954..	388	45,584	1,409	77,928	1,021

Pepper is produced in sufficient quantities for export, and the favourable prices under the Government Guaranteed Purchase Scheme have in no small measure helped to stimulate increased production in recent years. The following is a statement of the exports of pepper for the last five years :—

Export Trade in Pepper (Black)

Year	*Export cwt.*	*Value Rs.*
1950	3,744	2,325,855
1951	4,690	3,870,550
1952	5,630	4,154,087
1953	3,685	2,225,760
1954	4,683	1,413,938

Betel is grown almost exclusively in home gardens in villages in the wet zone, and in parts of the dry zone in Mannar and the Jaffna Peninsula where the crop is irrigated from wells. The cultivation of the crop in the Northern Province has been described in detail by Paul *et al.* (1937). The plants are trained on live supports such as *Erythrina Indica* Lam (T. *mullumurukku*) and *murunga* (*Moringa oleifera* Lam.) which are lopped periodically to provide the necessary light shade, but in the wet zone only dead supports are used for commercial betel varieties, although semi-wild types such as *Gasbulath* and *Galbulath* are allowed to climb jak and other live supports.

The cultivation of pepper is confined to the wet and semi-dry zones where it is grown both as a village garden crop, and as a subsidiary plantation crop in tea and rubber estates. The vines are trained on kapok and other suitable trees alongside the boundary fence and on shade trees such as Grevillea and jak.

Hardwood supports which last 15 years or more are used in commercial plantations in Sarawak where owing to the prevailing conditions of high rainfall and low sunshine the vines tend to run to leaf and are less productive under the shade of live supports which also compete for plant nutrients in the soil. Picking costs are less with vines trained at a reasonable height on dead supports spaced uniformly in the field.

Propagation of Betel

The normal practice in Ceylon is to propagate betel and pepper vegetatively from cuttings since plants raised from seed are weak and slow in growth. In the case of betel the cuttings are planted directly in the field during the rainy season, but many growers in Jaffna, especially in the Silalai area, prefer to strike the cuttings under shade in nurseries and plant the rooted material in the field in April and May because of the high incidence of Bacterial Leaf Spot disease during the wet season.

The type of cutting used in Jaffna for planting in the field is the stem cutting with three nodes and three leaves of which the lowest leaf is removed before planting, the middle leaf is rolled round the upper stem and the top leaf is wrapped round it to prevent dessication. These cuttings are taken from the main vine and primary vegetative branches known as *saippu* in which adventitious

roots occur at the nodes. Shoots of the *mathu* type which furnish the commercial leaf of high quality are not used for the purpose ; they have no adventitious roots at the nodes, but often produce catkins in the leaf axils. Skilful and judicious pruning is necessary nearly every two months from planting for the production of *mathu* shoots which may take a year or more to appear.

The cuttings are planted with the lowest node below and the middle node at soil level. After about three weeks the leaves are unwrapped in the evenings and tied again four to five days later till they become hardened. With cuttings planted directly in the field casualities can be so heavy as to necessitate replanting of the entire area. Rooted plants from nurseries are more easily established and make more uniform growth than cuttings. Trials were therefore undertaken to determine the best type of cutting to be used and the most suitable rooting medium for the propagation of the cuttings in nurseries.

The following materials were selected :—

Type of cuttings.

(*a*) Stem cutting with at least 3 nodes and leaves.

(*b*) Single leaf cuttings with a suitable node and leaf.

Rooting media.

(*a*) Coir dust and fibre.
(*b*) Sand.
(*c*) Soil.
(*d*) Sand and soil in equal parts.

The design of the experiment was a 4 × 4 Latin square with split plots containing 20 cuttings each, of which ten were stem cuttings and the rest single leaf cuttings, the total number being 320. The four different rooting media were randomized in the plots. The whole experimental nursery area was provided with overhead shade and hand-watered regularly. The cuttings were all planted on 14th July 1954, and observations on growth were recorded weekly. Most of the stem cuttings remained fresh and began to produce new shoots from the leaf axils in three to four weeks but quite a few of the leaf cuttings showed signs of wilting. All the cuttings were uprooted on September 27, 1954, for examination of the root system and records were taken of the weight of the new shoots and roots produced on each cutting. The relevant data are given in Table I.

Table I—Weight of new shoots and roots produced in different media

Rooting Medium	*Stem Cuttings*			*Single Leaf Cuttings*			*Av. wt. in grms. of shoots of both stem and leaf cuttings*	
	Per cent. strike	*wt. in grms. of new shoots*	*wt. in grms. of new roots*	*Per cent. strike*	*wt. in grms. of new shoots*	*wt. in grms. of new roots*	*New shoots*	*New roots*
1. Coir	92·5	48·4	36·9	80·0	23·8	17·8	36·1	27·4
2. Sand	92·5	29·2	15·1	85·0	20·3	10·4	24·8	12·8
3. Soil	100·0	53·3	14·6	87·5	33·0	8·4	43·1	11·5
4. Sand and soil	97·5	43·2	15·5	92·5	25·9	7·6	34·5	11·6

Although stem cuttings have shown a slightly higher percentage of rooting than leaf cuttings in all the different media both types have made significantly more root growth in coir dust and fibre than in either sand or soil, and more vegetative growth in soil than in the relatively infertile sand. Stem cuttings have shown more growth of roots and shoots than leaf cuttings in each of the four different rooting media under study ; they are the best type of material for planting in the field or the nursery. They strike root even more readily in glass or cloth covered propagators of the type used for rooting cacao cuttings in which high humidity is maintained by the constant drip of water from an overhead pipe line during day time.

Imported shoots of the Deccan betel variety from Poona which produces light coloured leaves of high quality, and the *Katpuram* and *Pachchai* varieties from Trichy, South India, developed numerous adventitious roots from nearly every node in the humid atmosphere inside the propagator within a week, and were successfully multiplied by further subdivision.

Table II—Analysis of Variance Weight of Betel Roots in Grammes)

Factors	*Degrees of Freedom*	*Sum of Squares*	*Variance*	*F*	*P=·05*	*P=·01*
Columns	3	313·6	104·5			
Rows	3	148·3	49·4			
Rooting medium	3	1,434·9	478·3	7·4	4·76	9·78
Error (*a*)	6	387·0	64·5			
Type of cuttings	1	721·1	721·1	20·1	4·75	9·33
Interaction	3	259·2	83·1			
Error (*b*)	12	429·8	35·8			
Total	31	3,693·9				

Average weight of roots in gms.

Rooting medium	*Coir*	*Sand*	*Soil*	*Soil and Sand*
	27·4	12·8	11·5	11·6

Significant difference 10·0

Type of cuttings	*Stem cutting*	*Leaf cutting*
	20·6	11·1

Significant difference 6·5

Table III—Analysis of Variance (Weight of Betel Shoots in Grammes)

Factors	*Degrees of Freedom*	*Sum of Squares*	*Variance*	*F*	*P = ·05*	*P = ·01*
Columns	3	1,152·7	384·2			
Rows	3	2,328·5	776·2			
Rooting medium	3	1,375·9	458·6	7·2	4·76	9·73
Error (*a*)	6	381·2	63·5			
Type of cutting	1	2,525·8	2,525·8	15·5	4·75	9·33
Interaction	3	264·8	88·3			
Error (*b*)	12	1,976·7	164·7			
Total	31					

Average weight of shoots in gms.

Rooting medium	*Sand*	*Soil and Sand*	*Coir*	*Soil*
	24·8	34·6	36·4	43·2

Significant difference 10·0

Type of cutting	*Stem cutting*	*Leaf cutting*
	43·5	25·8

Significant difference 14·0

Propagation of Pepper

Similar trials were carried out with pepper which is generally propagated from stem cuttings taken from the terminal branches of young vigorous vines. Lateral branches are not suitable for propagation. Sandford (1952) has described the method of selection and preparation of cuttings in Sarawak where they are taken from immature vines which receive regular pruning during the first two years. Cuttings from mature vines do not strike root easily and are slow in growth. The cuttings are prepared in advance by pinching the terminal bud and removing the leaves and side branches from about the third to the seventh node from the top. The cutting is removed for planting 7 to 10 days later when the new terminal bud has begun to grow. Each cutting will have about 6 to 7 nodes of which 4 are buried when the cutting is planted slantwise at a shallow depth in the ground and shaded with bracken.

No attempt is made to prepare cuttings in this manner in Ceylon. They are taken with 6 to 7 nodes from healthy productive vines and planted with 3 to 4 nodes below ground level in nurseries. The basal cut is made about one inch below the node and the cuttings are provided with overhead shade and handwatered regularly during the drought.

Both stem and single leaf cuttings were used in the trials with different

rooting media. The leaf cuttings consists of a single leaf with sections of the internode at the two ends, the basal cut being made just below the lower node which is defoliated. These single leaf cuttings showed 70 per cent. rooting compared to 44 per cent. by stem cuttings. They produced more roots like stem cuttings in coir than in sand or soil. Most of them remained green for a long period and developed shoots from the leaf axils, but in the case of stem cuttings quite a number dropped the leaves and died back. Stem cuttings which were defoliated at the time of planting completely failed to strike root.

Apart from the ease with which single leaf cuttings strike root they are available in larger numbers than stem cuttings and are easier to transplant. Further trials are in progress to determine the suitability of leaf cuttings taken from vigorous inmature vines of the type used in Sarawak. It is expected that with such material the percentage strike may be even higher than 70.

References

1. Paul W. R. C., Gunaratnam, S. C., Chelvenayagam, V. V. (1937) The Betel Vine in the Northern Province. *Tropical Agriculturist* LXXXIX, pp 281—298.

2. Sandford, H. (1952) Pepper in Sarawak. *Malayan Agricultural Journal* XXXV pp. 208—214.

Training and Pruning the Passion Vine

E. P. BUELL

Received 14.12.54

TWELVE YEARS of passion vine (*Passiflora edulis* Sims.) culture produced little or no fruit at the Experiment Station, Peradeniya. The vines ran into leaf and formed a tangled mass of foliage and wood in a very short period. This was aided by uniform soil moisture content and a high level of fertility, particularly, nitrogen. The vines were all trained on live and dead fences as well as on roofs of old huts. The vines received little or no sunlight and the circulation of air was impeded. As a result, local temperature and humidity were fairly high to stimulate a greater vegetative phase. No systematic pruning or manuring was done except severe cutting, annually, to reduce the vegetative phase. This treatment, on the contrary, encouraged greater vegetative activity due to the decrease in the relative amount of carbohydrates (Naik 1947). This really emphasises the maxim that "everybody cuts but few prune". A method of pruning had therefore to be studied in relation to the vine and its environment under mid-country wet zone conditions. A particular method of pruning, might restrict crop production under one type of soil and climate, but the same method might increase yields under quite a different set of conditions (Chandler 1925). Likewise, all vines do not respond to one standard method of pruning, but methods have to be evolved to suit the characteristics of a particular type of fruit tree, in relation to its growth and its fruiting habits (Hayes 1945). If the drastic pruning of the grape-vine be given to the passion, the latter will perish although the grape vine will respond and bear abundantly. The present study is the investigation of suitable methods of pruning of passion vine, which would increase the production of fruit.

Materials Employed

Two varieties of *Passiflora* are grown in Ceylon for their fruit. The purple fruited variety is more suitable for Up-country elevations. The fruit of this variety is smaller but superior in flavour to the golden or yellow fruited variety. The golden fruited variety is preferred for the low-country wet and dry zones. The fruits of this variety are bigger and more rounded containing higher amounts of edible portion. The flavour, however, is a little inclined on the acid side. The fruits of both varieties are largely used in the preparation of 'passiona', a most popular fruit cordial. There is a great demand for this fruit drink in all parts of the world particularly in the United States of America. In Ceylon the effective demand is not fully met as the fruits are not easily and consistently obtained from the vines and no large-scale cultivation is found, owing to the absence of certain cultural practices that promote fruit production. For Peradeniya conditions therefore the yellow or golden fruited variety was selected for

purposes of this study. This variety is protandrous and the seedling progeny would therefore exhibit a stream of variation amongst themselves. To eliminate this variability among the plants, cuttings obtained from one individual vine were used. Stem cuttings of the standard material, from matured lateral branches were first raised in nursery beds and were subsequently transplanted in the field when they were three to four months old. They may be planted even earlier provided they have rooted sufficiently and grown to a height of nine inches to a foot.

Lay Out and Design

All vines, with the exception of a few, have to be trained on to some support for satisfactory growth and production (Ebbot 1948). In this study the cheapest and the most convenient method was adopted. Vertical double cordon system trellises were erected to a length of 120′ to accommodate ten vines. The height of the trellises was 7′ with strands of wire at intervals of 3′, 2′ and 2′ starting from ground level. The wires were well stretched through the supports at every 12′. Trellises were constructed 8′ apart in a north-south direction to secure the advantage of greater duration of solar insolation. Vines were then planted out at the centre of two supports giving thereby a spacing of 12′ in the rows and 8′ between the rows. They were trained to a single stem by pinching off the laterals till they reached a height of 7½′. At this height the terminal bud was pinched off to encourage the production of laterals. Two vigorous laterals directly opposite each other were allowed for training on the two upper strands of wire. The lowest strand was left free for subsequent securing of fruiting spurs in order to keep them well spaced in an orderly manner. The laterals were trained as leaders on the strands in opposite directions by tying them to the strands by stages as growth proceeded. The terminal buds of leaders on the strands were pinched off at 6′ to encourage the growth of vigorous foundation spurs, which produce fruit in the first season (see Fig. I). The design of the experiment was the simple randomised block where each block is a single trellis consisting of a group of ten vines. Treatments were imposed on them at random (Cochram and Cox 1950).

Treatments

Treatments imposed formed two parts of the experiment. The first part consisted in establishing the significance of pruning as opposed to control or no pruning. Some growers claim that pruning gives bigger and better crops, while others are of opinion that just as big crops are obtained from unpruned vines, but both schools of thought have admitted that the quality of fruit obtained from unpruned vines is inferior (Willis 1948). The object of the first part of this experiment was to test whether pruning encouraged bigger crops of better quality. There were three treatments, namely, three node, seven node and no pruning of the foundation spurs. The foundation spurs are the normal tertiaries that give rise to flowers. The fixation of the severity of pruning namely three and seven nodes was arbitary and not in a regular succession. The second part of the experiment consisted of pruning treatment in regular succession of severity beginning

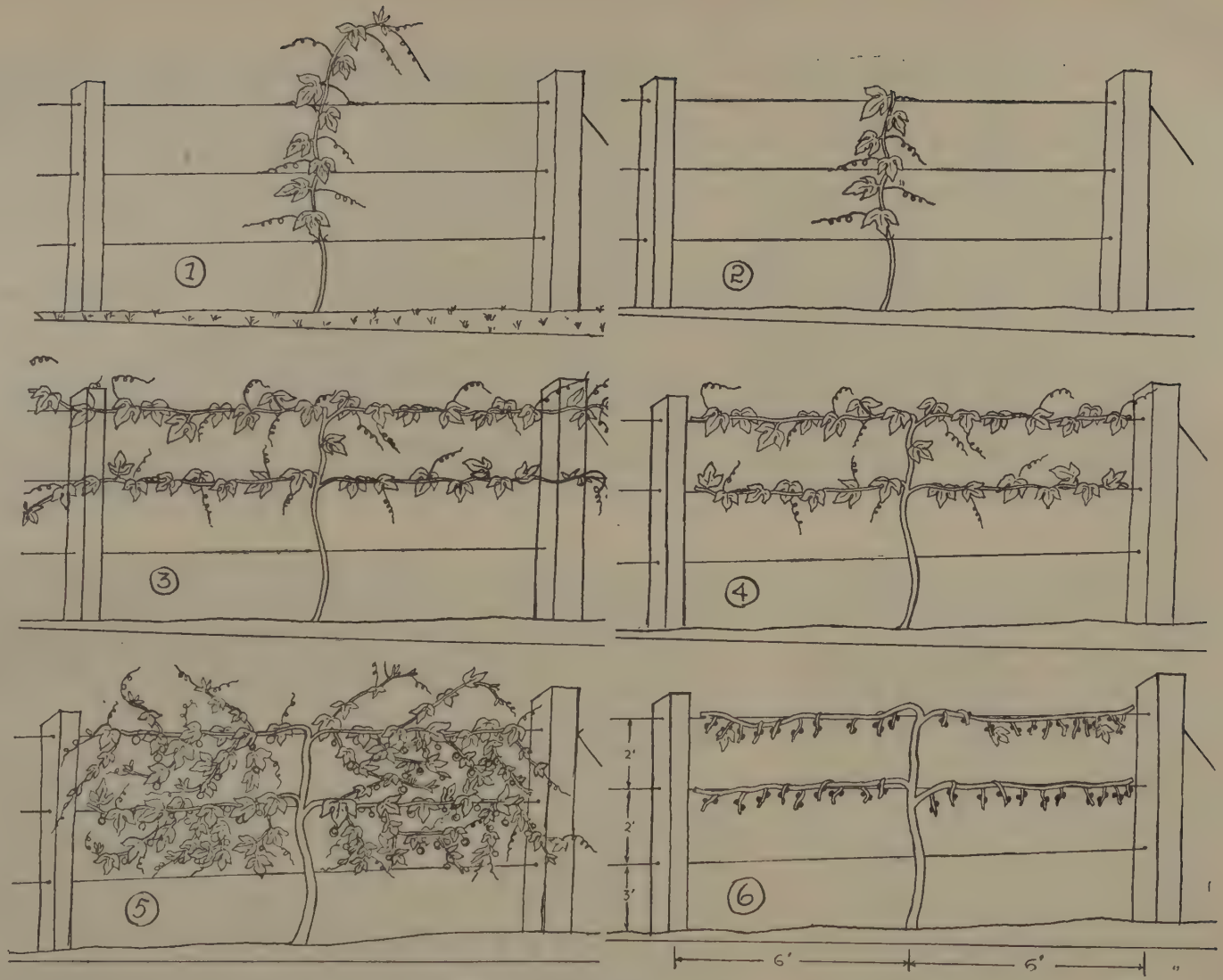


FIG I.—Training the Passion Vine. 1. Trained to a single stem. 2. Terminal bud nipped at 7½ feet. 3. Laterals trained on upper strands of wire as leaders. 4. Leaders nipped at 6 feet, to encourage growth of foundation spurs. 5. Foundation spurs develop on laterals. 6. Fruits form on foundation spurs.

with the first node of the fruiting spur and ending up with the fifth node together with control or no pruning. The same design was used with an increase in the number of treatments (Pearce 1953).

Season for Treatments

The season of pruning has been found to influence the 'effect'. The response has been found to be variable with the season in respect of yield of fruits, their quality and the vigour of fruiting spurs produced. During dry periods as well as wet periods pruning has had adverse effects on the vines causing dry and wet rot respectively. Vigour of growth has also been found to be poor if pruning is done during a prolonged dry spell but excessive when treated during wet weather. For greater production of fruit the period of pruning should be adjusted with the natural flowering period of the vines which occurs during the months March-April. The fruiting spurs take two to two and half months to mature and it is only at the end of this vegetative phase that reproduction begins. Pruning during January-February was found to suit the vines from the point of view of their natural flowering habits. Flowers do not set fruit readily during heavy showers of rain, and the distribution of fruit could be controlled by supplying artificial conditions such as irrigation during the dry spells. The fruits are in season normally during the period June to December but the biggest yields are obtained from July to September. The period of pruning also determines the seasonal distribution of fruit and the number of harvests. In the first part of this experiment there were fourteen fortnightly harvests and in the second part seven monthly harvests.

Treatment Effects

Apart from the yields recorded in experiments one and two there have been other important observations. There was a general dwarfing effect on vines treated, the exception being the control which was vigorous. The production of the number of fruiting spurs decreased as the severity of pruning increased, but the reduction of fruiting spurs increased the size of fruit. The production of flowers was simultaneous and not gradual, which was reflected in the harvests. The vines gradually lost vigour and did not last long, the productive limit being four years. Controls lasted for greater periods but with a poor performance. With artificial pollination a greater number of flowers set into fruit. This was the observation in the first part of the experiment. In the second part of the experiment no hand pollination was done and the yields decreased considerably. Certain species of ants have been found to be satisfactory pollinators.

Conclusions

The analyses of the first part of the experiment showed that pruning was significantly superior to no pruning, and that of three and seven node pruning, the three node pruning gave significantly higher yields. This part of

Table I—First Experiment

Harvests	Number of Fruits Picked			
	3 Node	*7 Node*	*Control*	*Total*
1	18	4	13	35
2	50	52	3	105
3	100	136	100	336
4	65	189	205	459
5	172	108	97	377
6	278	82	53	413
7	128	72	45	245
8	72	122	50	244
9	125	36	11	172
10	180	75	72	327
11	163	43	61	267
12	275	128	120	523
13	57	14	18	89
14	34	0	0	34
Total	1,717	1,061	848	3,626

Table II—Second Experiment

Harvests	Number of Fruits picked						
	Control	*1 Node*	*2 Node*	*3 Node*	*4 Node*	*5 Node*	*Total*
1	38	92	184	171	163	138	786
2	15	73	95	127	65	35	410
3	27	55	105	56	60	41	344
4	7	4	5	4	14	0	34
5	9	10	25	13	12	16	85
6	0	10	22	16	0	0	48
7	16	13	12	19	17	22	99
Total	112	257	448	406	331	252	1,806

the experiment was in the nature of a pilot trial and the choice of three and seven nodes for pruning treatments was arbitrary.

A more sensitive experiment to determine exactly what severity of pruning would give the highest yields formed the second part of this investigation. Pruning treatment ranged at all node intervals beginning with one and ending with five. It was not considered necessary to continue beyond the fifth node as three node pruning had already given the highest yields in the first part of the experiment.

The analyses of the second part of the experiment also revealed that pruning was superior to no pruning. It was also found that there was no significant difference between one, three, four and five node prunings. Two node pruning however gave a significant yield. The conclusion appears to be that the best interval of pruning treatment is at the second node. The yields were calculated by 'fruit count' but the significance would have been still more intensified if the calculation was based on the weight of fruits or still better on the weight of edible pulp. The analyses of variance and the data on which these calculations were based are given at the end of this article.

Summary

The results of experiments on pruning of passion vine for fruit, conducted at the Experiment Station, Peradeniya, have been discussed. Increases in yield obtained by pruning have also been statistically analysed. The response to two node pruning was found to be significantly greater than others. The system of training to facilitate pruning has been dealt with.

Acknowledgments

I am greatful to Mr. A. V. Richards for useful criticism and to Mr. P. Canapathipillai for the statistical analyses.

References

GARDNER, BRADFORD and HOOKER JR.—*Fundamentals of Fruit Production*—Mc Graw—Hill, Book Co., London.

K. C. NAIK—*South Indian Fruits and their Culture*—P. Varadachary & Co., Madras.

W. B. HAYES—*Fruit Growing in India*—Kitabistan, Allahabad.

W. H. CHANDLER—*Principles of Fruit Growing*—Hanghton Miffin, Boston and New York.

H. W. EASTWOOD—Pruning Passion Fruit Vines—*Agricultural Gazette, New South Wales,* Vol. 51.

I. E. EBBOT—Passion Fruit Growing—*Journal of Agriculture, Victoria, November* 1948.

W. G. COCHRAN and G. M. COX—*Experimental Designs*—John Wileys & Sons, London.

S. C. PEARCE—Field Experimentation with Fruit Trees and other Perennial Plants—*Technical Communication No.* 23, *Commonwealth Bureau, East Malling.*

K. D. MC GILLIVORY—Passion Fruit and Culture—*Agricultural Gazette, New South Wales, Vol.* 58.

J. M. WILLIS—Passion Fruit Growing in Southern Queensland—*Queensland Agricultural Journal, Vol.* 66.

ANALYSIS OF VARIANCE

To Compare 3 and 7 Node Pruning and No Pruning
(First Experiment)

	DF.	*S. S.*	*M. S.*	*F.*
BETWEEN HARVESTS	13	106,453	8,189	
BETWEEN NODES				
Control *vs.* Pruning	1	13,937	13,937	5·59*
Between Prunings	1	15,369	15,369	6·17*
ERROR	26	64,744	2,490	
Total	41	200,503		

Standard Error per plot = $\sqrt{2{,}490}$ with 26 d.f.

Standard Error of Mean Difference = $\sqrt{2{,}490\ (1/14 + 1/14)} = 18{\cdot}8$

	Mean Yields
3-Node Pruning	123
7-Node Pruning	76
Difference	47

t — 47/18·8 = 2, 50* on 26 d.f.
i.e. $0{\cdot}01 < P < 0{\cdot}02$

ANALYSIS OF VARIANCE

To Compare 1, 2, 3, 4, and 5 Node Pruning and No Pruning.
(Second Experiment)

	DF.	*S. S.*	*M. S.*	*F.*
BETWEEN HARVESTS	6	76,462	12,744	
BETWEEN NODES				
Control *vs.* Pruning	1	4,092	4,092	6·99**
Between Prunings	4	6,421	1,605	2·74*
ERROR	30	17,559	585	
Total	41	104,534		

Standard Error per plot = $\sqrt{585}$

Standard Error of Mean Difference = $\sqrt{585\ (1/7 + 1/7)} = \sqrt{167} = 12{\cdot}9$

Significant Difference between Means (5% level) = 2,042 × 12·9 = 26·3

	5-Node	*1-Node*	*4-Node*	*3-Node*	*2-Node*
Mean Yields	36	37	47	58	64

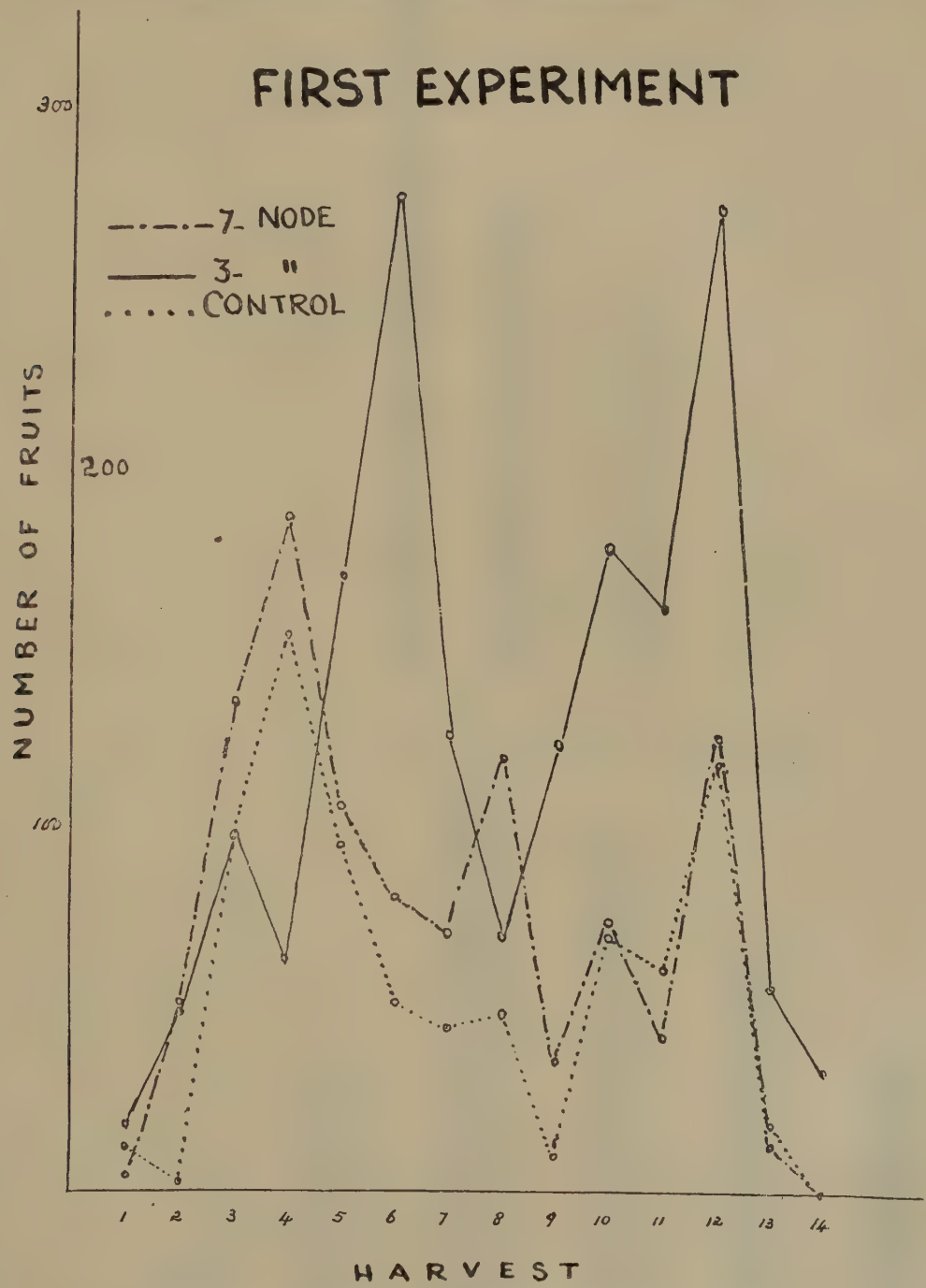


FIG. II.—Graph showing number of fruits picked per harvest in each treatment of Experiment 1.

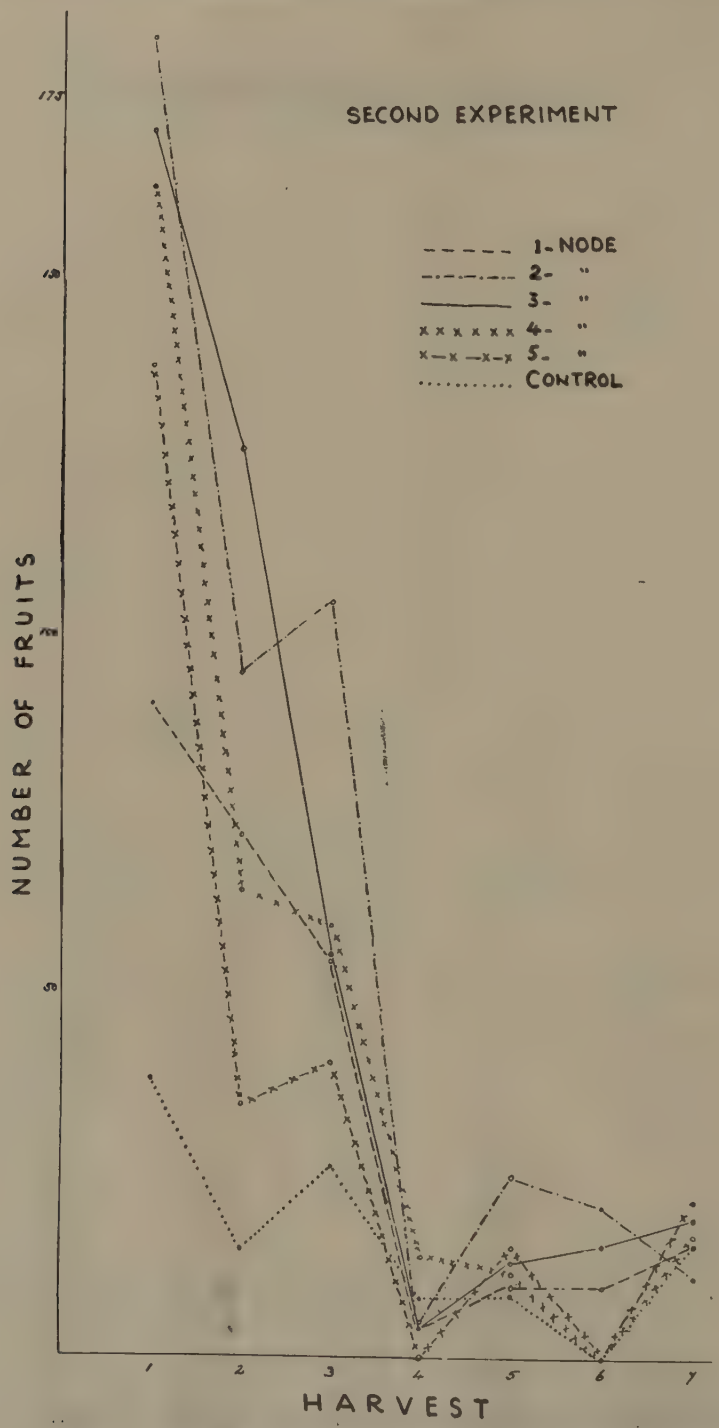


FIG. III.—Graph showing numbers of fruits picked per harvest in each treatment of Experiment 2.

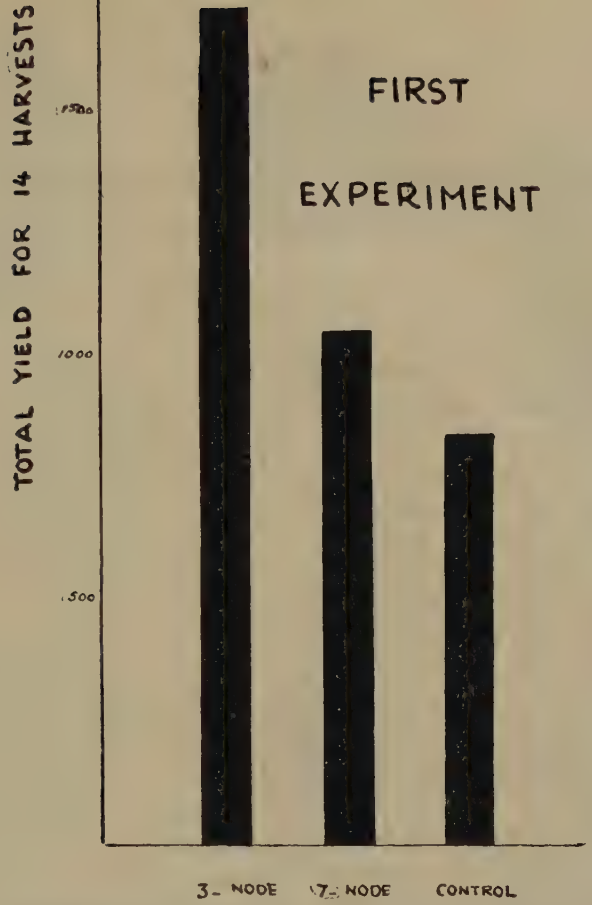
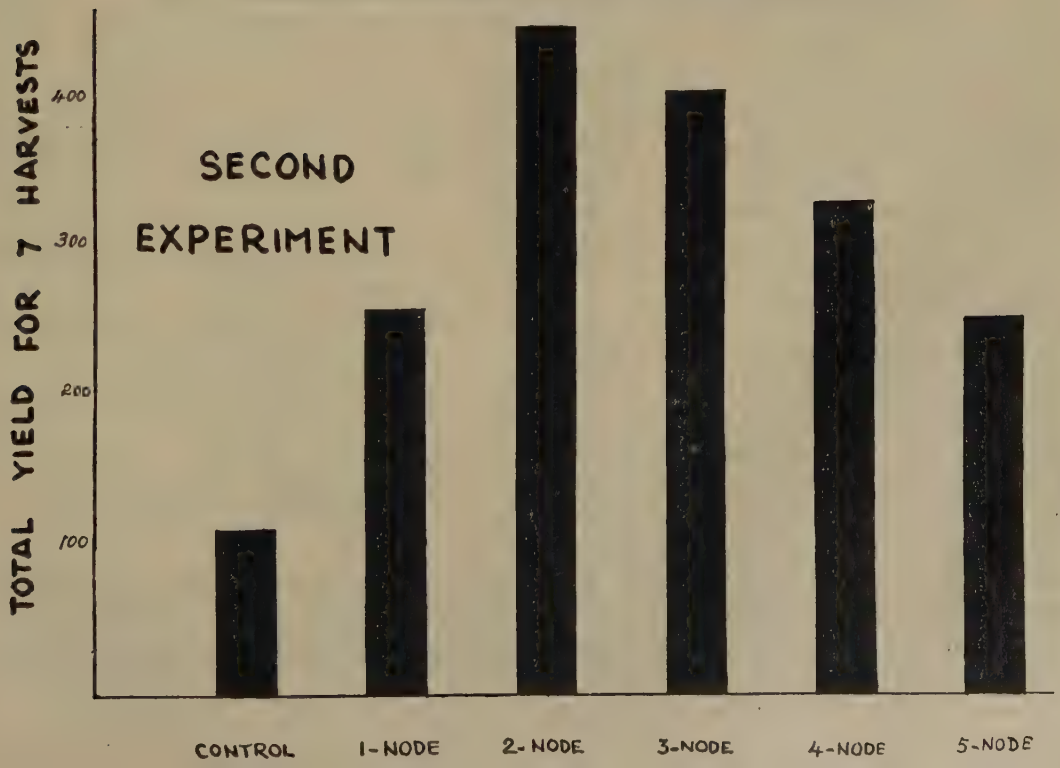


FIG. IV.—Comparative study of the total yield of fruits for each treatment in Experiment 1.



A Preliminary Study on the Control of Red Bug of Bandakka

P. MANICKAVASAGAR

Received 28.8.54

THE RED BUG of Bandakka, *Dysdercus cingulatus* (S. *Bandakka Makuna*, T. *Vendich-Chev-Maddu-Poochi*) commonly attacks plants belonging to the families Malvaceae and Sterculiaceae. The favourite food plants of this bug besides bandakka *Hibiscus esculentis*, are cotton *Gossypium* Sp. (S. *Kapu*; T. *Paruthi*) and red cotton *Bombax malbaricum* (S. *Katu Imbul*; T. *Paruthi*).

The adult bug is medium sized, being about 20 mm. in length and is dull to bright orange in colour. On the underside of its body are white cross bands and spots. The first pair of its wings, which covers the folded membraneous second pair, has the distal ends black and proximal portions coloured either orange red or dull straw with a black spot in the middle of each wing. Several of these bugs in the adult and nymphal stages may be seen to cluster on pods and tender shoots of bandakka during feeding. The adults are active insects which run rapidly when disturbed, but seldom take to the wing.

The adults as well as nymphs have similar feeding habits due to the possession of the same type of piercing and sucking mouth parts and cause a considerable amount of damage. In feeding, the bugs have shown preference towards the immature pods and shoots, but they have been found to attack the hard mature seeds softened by rain. During a severe attack the pods, flower buds and shoots may shrivel up and even drop. The plants get stunted with consequent reduction in yield of marketable pods. This pest has proved itself to be a worse menace on cotton. Apart from the direct damage due to feeding habits, the staining of the lint by the bugs at harvest, lowers its quality.

An outbreak of this pest occurred during *maha* 1953-54 at the Experimental Station, Thirunelvelli, Jaffna, in about a quarter of an acre plot of bandakka, which was a varietal trial laid down by the Agricultural Research Officer, Jaffna. In the absence of parasitic flies, and the most effective predaceous bug, *Antilochus nigripes*, there was a rapid build up of the pest.

A preliminary investigation on the control of the red bug with the following chemical formulations was carried out :—

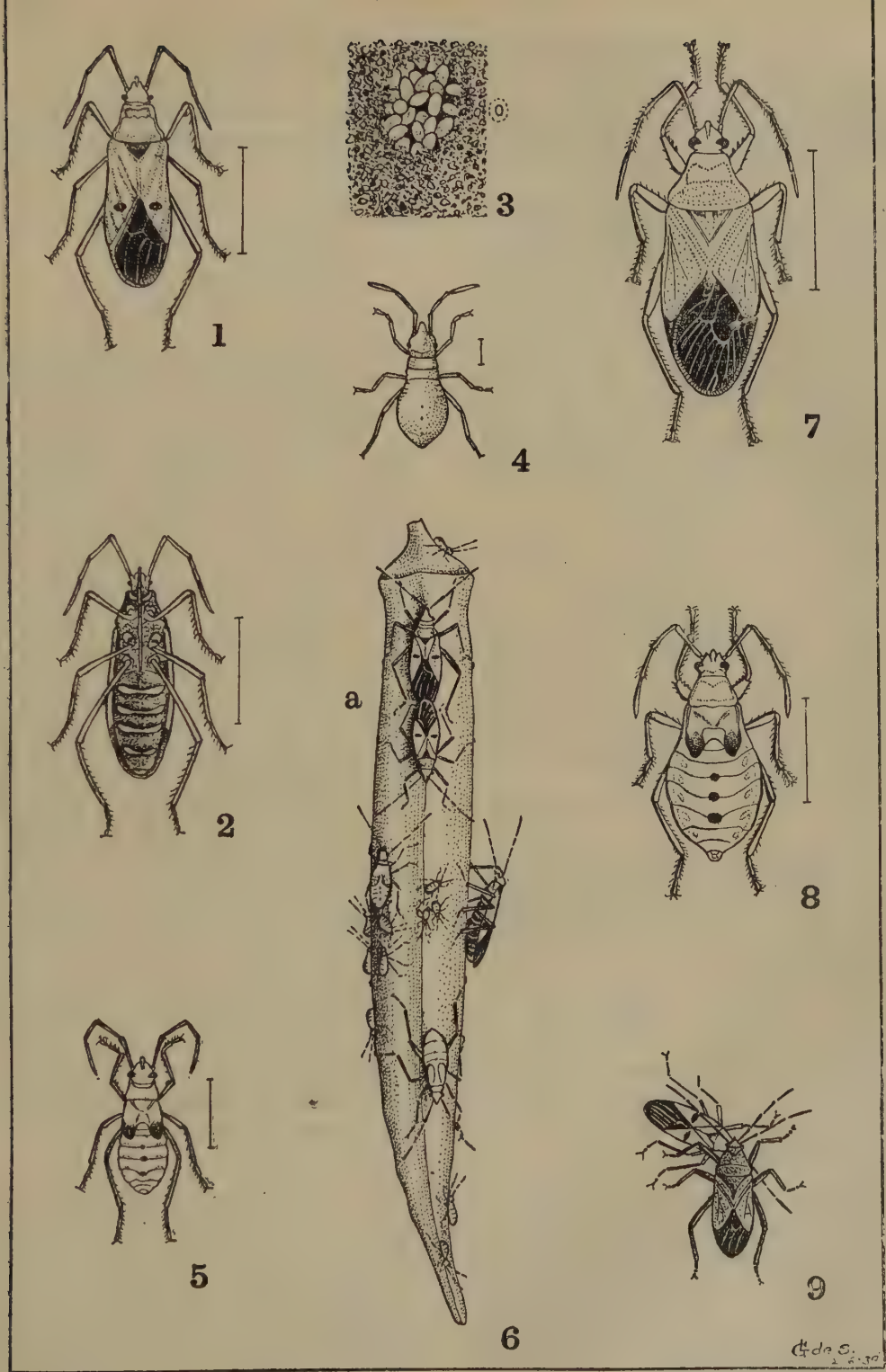
DDT 18 per cent. Emulsifiable concentrate

BHC 10 per cent. Emulsifiable concentrate

Chlordane 74 per cent. Emulsifiable concentrate

Dieldrin (1.5 lb. actual dieldrin per U.S. gallon of concentrate).

The plot of bandakka had forty-one rows of plants, forty of which were divided into ten blocks, each containing



BLOCK BY SURVEY DEPT. CEYLON.

1. Dorsal aspect of adult Red Cotton Bug. 2. Ventral aspect of same. 3. Mass of eggs laid in soil. 4. Second stage cotton bug. 5. Fifth stage bug showing wingpads. 6. Bandakka pod showing a mating pair of bugs at *a*, and other stages of bug feeding. 7. Adult predaceous bug. 8. Fifth stage predaceous bug, showing wingpads. 9. Predaceous bug feeding on cotton bug.

6 and 9 are natural size. The lines near others show natural sizes

four rows. The plants were of very good growth, carrying the first few pods and a large number of flowers.

An estimate of the pest infestation before the commencement of the treatment gave an average of eight bugs per plant on ten plants selected at random. These counts included the nymphs as well as adults. Immediately after the counts were made the blocks were treated with the following concentrations of insecticides (per cent. actual insecticide in prepared spray), and the treatments were randomised :—

Block 1	..	DDT	.. ·03%
Block 2	..	Dieldrin	.. ·75%
Block 3	..	Untreated check	—
Block 4	..	Chlordane	.. ·2%
Block 5	..	BHC	.. ·003%
Block 6	..	Dieldrin	.. ·5%
Block 7	..	Chlordane	.. ·15%
Block 8	..	Untreated check	—
Block 9	..	DDT	.. ·05%
Block 10	..	BHC	.. ·02%

Each plant was thoroughly sprayed at the rate of 1½ gallons of spray solution per treatment on each block, using a knapsack sprayer.

There was very bright and hot weather on the day of spraying and on the next day. On the second day after spraying there were heavy showers, while a drizzle persisted on the third day after the treatment.

Five days after the first treatment, a second treatment with the same insecticides was carried out using a higher concentration as the insect population had not been affected by the first treatment. The second treatment was carried out using the same equipment and the same volume of spray per block. The concentrations of the insecticides in the prepared spray were as follows :—

Chlordane—·9% and ·4%
DDT—·2% and ·1%
Dieldrin—3% and 1·5%
BHC—·1% and ·06%

Three hours after treatment a complete paralysis was noticed in the case of nymphs, and twitching of the limbs in the adults. On the second day after the second treatment, a representative random count of the insect population showed a 100 per cent. mortality in blocks 1, 2, 4, 5, 6, 7, and 9. In blocks 3, 8, and 10 the intensity per plant was on an average 12, 8, and 1 respectively. In all the treatments except those with Benzene hexa chloride at a low concentration, there was complete freedom from the pest. Unsprayed check blocks too showed a reduction in the insect population probably due to spray drift. The insecticides had no phytotoxic effects on the sprayed plants at the concentrations used.

Eighteen days after the second treatment a reinfestation of the plants by these bugs was noticed. Mostly nymphs and a very few adults were found in this instance. This would suggest that the insecticides under Jaffna conditions have no important residual effects against this pest for more than fourteen to eighteen days.

On the basis of the gallonage of spray required per block, about 40 gallons of spray liquid will be required per acre using a knapsack sprayer. Of all the chemical treatments employed DDT has proved the cheapest, while it is as effective as any of the other chemicals used. For complete control of

Mortality of Red Bugs 24 hours after spraying with a Series of Insecticides at various Concentrations

Plot No.	*Concentration of Insecticide*	*Dilution Rate in 1 Gallon of Water of Formulation*	*Average Infestation of Bugs per Plant*					
			Prior to spraying			*24 hrs. after spraying*		
			ADULTS	NYMPHS	TOTAL	ADULTS	NYMPHS	TOTAL
1	D. D. T. ·1%	1 fl. oz.	9	5	14	—	—	—
2	Dieldrin 3%	2 ,, ,,	5	4	9	—	—	—
3	Control	—	7	7	14	11	1	12
4	Chlordane ·9%	2 fl. oz.	5	—	5	—	—	—
5	B. H. C. ·06%	1 ,, ,,	10	5	15	—	—	—
6	Dieldrin 1·5%	1 ,, ,,	5	7	12	—	—	—
7	Chlordane ·4%	1 ,, ,,	8	5	13	—	—	—
8	Control	—	8	12	20	8	—	8
9	D. D. T. ·2%	2 fl. oz.	5	3	8	—	—	—
10	B. H. C. ·1%	2 ,, ,,	8	4	12	1	—	1

an infestation of red bugs on bandakka, about two pints of a 15 per cent. to 25 per cent. DDT emulsifiable concentrate will be required. This would work out at a cost of about Rs. 4.25 for insecticide alone per acre. In addition to its cheapness and its effectiveness it presents about the least hazard to human beings if harvesting is avoided for three weeks to a month after the last spraying with DDT.

Acknowledgment

I thank Dr. H. E. Fernando, Entomologist, for valuable help in the preparation of this paper.

A Feeding Trial with Chickens under Backyard Conditions

J. S. L. WHITE

Received 20.8.54.

No DATA are available in Ceylon on the value of local feeding stuffs in poultry feeding. We measure the nutritive value of feeds largely by their chemical composition, but their biological values can only be determined by actual feeding trials and by results obtained with respect to such factors as growth, maintenance and reproduction.

In order to obtain some practical information on feeding of chickens under backyard conditions this trial was set up. Local feeding stuffs with the exception of a small percentage of wheat bran which was used in the chick mash only, were used in this trial.

The duration of the trial was 500 days, from February 18, 1953, to July 3, 1954.

Source of Stock

102 pure-bred Australorp eggs of average size and sound shell were obtained from the Coconut Research Institute, Lunuwila, and set in a Hearson's incubator. The birds in this Institute were originally obtained from the Government Farm, Ambepussa and hence are representative of the Australorps found in all the Government Farms in this country. Details of eggs set, fertility, hatchability, &c., are given in Table I.

Table I

No. of eggs set	102
Date set	28.1.53
Breed	Australorp
Fertility	91%
No. of chicks hatched ..	76
Date hatched	18.2.54
Hatchability of fertile eggs ..	81·8%
No. of deaths (1st month) ..	12
No. of deaths (after 1st month) ...	Nil
No. culled (2nd month) ..	6
No. of cockerels sold ..	31
No. of pullets culled (before housing)	10
No. of males housed (6th month) ..	2
No. of females housed (6th month)	15

Pullets that were stunted, out of condition, lacking in vitality and showing very poor development of secondary sexual characters were culled between the fourth and sixth months, in the same way as any intelligent poultryman will do if he wishes to eliminate in time birds that will increase his feed bill and give little or nothing in return. All excess cockerels were disposed of by the sixth month.

Management

All details of feeding and management were attended to personally by the writer. The chicks were reared up to one and a half months of age on a wire-netting 'sun porch' 10 × 4 × 1 feet with a house 4 × 4 × 1½ feet attached. The source of heat was an ordinary kerosene oil hurricane lantern. Thereafter, they were reared on the ground

in strict confinement within a wire-netting run approximately 65 square yards in extent. The house which had wire-netting sides and bottom, was supplied with closely spaced slats till the birds were four months old and then suitable perches were substituted. The runs had no vegetation at all.

All the birds were innoculated against Ranikhet disease at three months and a week later the sexes were separated. Neglect in vaccinating birds against 'Fowl Pox' resulted in the birds contracting this disease when they were five months old. By careful individual attention the disease was overcome but no doubt it affected sexual maturity and consequently egg production for about two weeks.

The majority of deaths among chicks under one month old was due to Pullorum (Bacillary White Diarrhoea). Thereafter, mortality was nil and the 15 pullets and 2 cockerels housed are all surviving at seventeen months of age.

The flock was treated for worms once a month with Phenothiazin beginning with the fifth month.

Feeding

Dry mash was fed *ad libitum*. Whole grain was not fed at all. Ingredients were purchased from a leading dealer in feedstuffs and mixed at home. Feed wastage by 'billing off' was eliminated by construction of simple feed troughs made of wood with 'lips' along the edges. The appetites of the birds were maintained by occasionally allowing the feed troughs to be emptied and leaving them empty for a short time. During very hot and dry weather if birds appeared to be going off feed, a little water was sprinkled on top of the mash. This helped to maintain feed consumption at a satisfactory level. Table II gives the mash mixtures used.

Table II

Ingredients	*% Mash Mixtures by Wt.*		
	0–8 wks.	*8 wks. to 4½ mths.*	*Pullets and hens*
Yellow Maize Meal	50	44	47
Coconut Poonac (Expeller 8.5% fat)	6	15	18
Fish Meal	22	18	12
Rice Bran (Gr. I)	15	20	20
Wheat Bran	5	—	—
Skim Milk Powder	2	1	—
Sterilized Bone Meal	—	1½	2½
Salt	—	½	½
Analyses of Mash—			
Protein (Approx.)	19	17·5	16
Calcium (Approx.)	1	1·3	1·35
Phosphorus (Approx.)	0·65	0·8	0·8

These mashes were compounded having reasonable regard for the recommended levels of protein, calcium and phosphorous for the different age groups. The other mineral and vitamin requirements were not considered important as the diet fed in this trial was presumed to contain these in sufficient quantities. Veterinary codliver oil containing 750 Vit. A. I. U. per gram and 75 Vit. D. I. U. per gram was mixed with the mash three times a week at 1 ounce per 5 pounds mash. Tender fresh green material such as *Ipomaea aquatica* (S. *Kankun*) and *Alternathera triandra* (S. *Mukunuwenna*) was also supplied three times a week at 1 pound per 100 chicks from two weeks to two months of age; at 2 pounds per 100 birds from two to four months; at 4 pounds per 100 birds from four to six months and at 6 pounds per 100 birds from six months onwards. No grit of any kind was provided up to one and a half months. Thereafter, birds had access to grit and sand found under natural conditions in the run, while shell grit was supplied *ad libitum*. Ample clean water in suitable water fountains was kept before the birds at all times.

Table III gives the average composition for practical purposes of all feedstuffs mentioned in this article.

Table III—Analyses of Feedstuffs (Per cent.)

Feedstuffs	*Crude Protein*	*Fat*	*Fibre*	*Calcium*	*Phosphorus*
Yellow Maize Meal	8	5	3	0·03	0·14
Rice Bran (Grade I)	12	15	10	0·08	0·4
Coconut Poonac (Expeller)	22	8·5	10	0·21	0·15
Fish Meal	45	4·5	—	4	2·5
Sterilized Bone Meal	—	—	—	29	15
Wheat Bran	17	4·5	9	0·15	1·3
Skim Milk Powder	35	1	0·2	1·3	1

Mash consumption. A record of the total monthly mash consumption of the whole flock was kept and details of approximate daily and monthly mash consumption per bird, and costs were calculated on the following basis:

Chick mash at 25 cents per pound.
Grower's mash at 24 cents per pound.
Layer's mash at 23 cents per pound.

The above rates include the cost of the cod-liver oil and green leaves. Table IV gives this information.

Table IV—Feed Consumption and Cost per Bird for seventeen Months

Mash Consumption		*Cost per Month*
Monthly (lb.)	*Daily (oz.)*	*Rs. c.*
1·2	·6	0 30
2·0	1·0	0 50
4·0	2·0	0 96
5·0	2·5	1 20
7·0	3·5	1 65
7·3	3·75	1 68
7·3	3·75	1 68
8·0	4·0	1 84
8·0	4·0	1 84
7·0	3·5	1 61
7·0	3·5	1 61
7·0	3·5	1 61
7·0	3·3	1 61
8·0	4·0	1 84
7·0	3·5	1 61
7·2	3·6	1 66
8·4	4·2	1 93

NOTE.—Costs are high as the feedstuffs were purchased from a forage dealer and include cost of transport by rail.

Results and Observations

The growth and feathering of chicks were very satisfactory. No deficiency symptoms were observed. There were only two cases of cannibalism. This was arrested by segregating the victims and hanging bundles of tender green material to keep the chicks occupied. Birds did not suffer from colds or any respiratory diseases.

Table V gives ages at first egg for 10 pullets. These data were obtained by observation of the birds and by examination per cloaca. The average age at sexual maturity for these 10 pullets was 170.4 days.

Table V—Sexual Maturity and Weight

Hen No.	*Age at 1st Egg (Days)*	*Wt. at 14 months (Pounds)*
4	154	3·75
2	159	4·25
6	160	4·50
17	161	4·25
23	165	5·00
3	171	3·75
1	174	4·75
7	185	5·00
5	185	5·25
10	190	4·75
8	—	4·25
13	—	5·00
21	—	4·25
20	—	5·00
15	—	3·75

The average weight of first egg was 1.5 ounces while the average weight of an egg three months later was 2.03 ounces, the highest being 2.4 ounces and the lowest 1.5 ounces.

Judging from the health and appearance of birds and egg production, it is unlikely that the pullets were forced into too early production, even if body weights appear to be below standard. This, however, is a matter that needs further experimentation because it

depends on the strain and parent stock too. One thing is certain, however, and that is, that sexual maturity of pullets in this country is considerably delayed due to poor feeding and, perhaps, due to indifferent management.

'All Mash' and No Grain system of Feeding

The following are some facts on the 'all mash' feeding system adopted in this trial :—

(*i*) It requires less skill on the part of the feeder than does a grain and mash system, which requires good judgment in regulating the proportions of grain and mash intake, hence even inexperienced labour will be suitable.

(*ii*) It requires less labour as weighing (if dry mash is fed) and feeding according to a schedule are not necessary.

(*iii*) If dry mash is fed it is more sanitary than wet mash feeding which attracts flies and favours spread of disease.

(*iv*) Birds are kept more contented throughout the day, but will not over eat as the mash is dry.

(*v*) Dry mash requires only half as much feed trough space as that required in wet mash feeding.

(*vi*) The mash in the 'all mash' system requires about 25 per cent. less protein than the mash in the 'mash plus grain' system. Hence making up a mash in the 'all mash' system presents less practical difficulties, as many feedstuffs high in protein are not required.

(*vii*) The poultryman must be alert to see whether feed consumption is maintained at a satisfactory level. If not, it will be necessary to adopt such devices as sprinkling a little water on the mash or withholding feed for short intervals.

Egg Production

Table VI gives the monthly total egg production records of the 15 pullets up to July 3, 1954. Egg production was maintained at 50 per cent. and over for eight consecutive months (Fig. I).

The total number of eggs produced by the 15 pullets during this period was 2,678. Mortality was nil. The average egg production per bird on the hen housed basis calculated by dividing the total number of eggs laid during the period by the number of pullets in the flock at the beginning of the period was 178.5.

Out of the 2,678 eggs produced, 1,305 were sold to a hatchery and to poultrymen for hatching. From reports received it appears that the fertility and hatchability and livability of chicks were very good which shows that the ration fed was suitable both for commercial layers as well as for breeding stock.

Table VI—Monthly Egg Production Record

Month	*Monthly Total*	*Daily Range*	*Average No. per Day*
1953			
July (9 days)	16	—	—
August	123	1–7	3·97
September	235	2–12	7·83
October	310	6–12	10·0
November	327	7–15	10·90
December	244	3–12	7·87
1954			
January	268	4–14	8·64
February	257	5–13	9·17
March	261	5–11	8·42
April	226	5–12	7·63
May	182	3–9	5·87
June	213	3–1	7· 1
July (3 days)	6	—	—

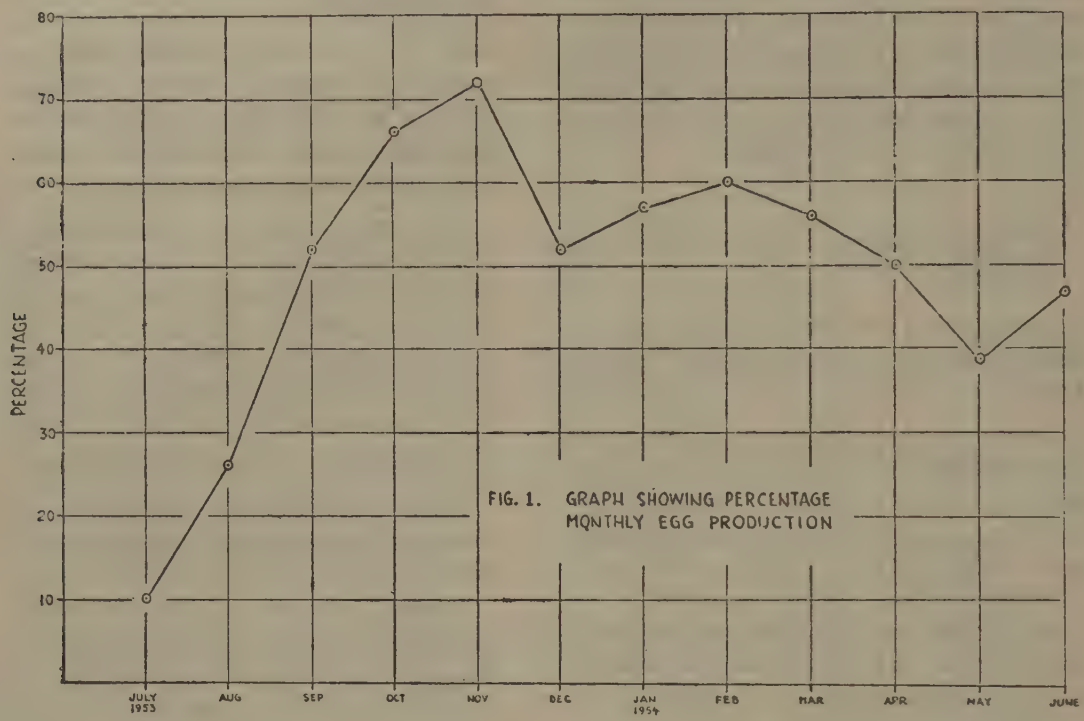


FIG. 1. GRAPH SHOWING PERCENTAGE MONTHLY EGG PRODUCTION

Conclusion

This trial indicates that :—

(*i*) The Australorp in this country has the capacity for fairly high egg production.

(*ii*) The main factor limiting egg production in Ceylon appears to be improper feeding and management and if this is overlooked there will be little use in importing better strains of chickens.

(*iii*) Up to 20 per cent. at least of fair quality rice bran can be used in the grower and layer mashes and 15 per cent. at least in, the chick mash without ill effects.

(*iv*) A fairly high percentage of fish meal of good quality can be used in a chick mash with advantage when vegetable protein feeds such as green gram, cowpea and gingelly poonac are comparatively more expensive.

(*v*) Suitable rations can be compounded without green gram and cowpea which are useful human foods.

(*vi*) Late sexual maturity that is commonly found in Ceylon is quite probably due to bad feeding and, perhaps, bad management too.

(*vii*) The backyard poultryman with a flock of 10 to 15 production bred birds, well fed and managed, can contribute very materially towards making this country self sufficient in eggs. In fact this trial indicates that for this country to be self-sufficient in eggs many large-scale poultry farms are not absolutely necessary. 15,000 more backyarders each producing 2,070 eggs per year with 15 hens will make up the deficit of 31 million eggs, which were imported in 1952.

Investigations on the Canning of Bananas

D. P. DIAS, N. L. JAIN AND GIRDHARI LAL

Received 29.4.55

BANANA IS one of the most important of the tropical fruits. In India it is widely cultivated in the States of Madras, Bombay, Bengal, Assam, Bihar, Travancore and Mysore. Large quantities of surplus fruit, particularly during the peak season, do not fetch reasonable returns to the growers, and occasionally go to waste. Economic utilization of such fruit should, however, be possible by suitably processing and preserving it.

A number of products are reported to have been prepared from both the ripe and unripe fruit (Anon, 1943 ; Von Loesecke, 1949 ; Anon, 1950). Some work on the canning of banana puree as a baby food and banana chunks in syrup, has also been reported recently (Guyer and Erickson, 1954 ; Board & Seale, 1954). Investigations undertaken at the Central Food Technological Research Institute, Mysore (India) on the canning of bananas in syrup alone or in combination with other fruits to form salads have shown that the product obtained in either case is of satisfactory quality and appears to have great possibilities for export to places where fresh bananas are not available. The present paper deals briefly with the experiments carried out in this connection, and the methods finally standardized.

Experimental

Raw Material. Bananas for these experiments were obtained from the local fruit market. Fully ripe yet firm fruit was used. Banana bunches are normally harvested by the growers when fully developed and mature but still green and hard. This green fruit is artificially ripened in different ways (Von Loesecke, 1949). At the fully ripe stage, the fruit pulp softens and the skin becomes loose and develops yellow, yellowish green, reddish grey or yellowish grey, &c., colour, depending upon varietal characteristics. In most cases, greyish or brownish flecks also start appearing on the surface.

The common varieties available in Mysore market, viz., *Rasbale, Salembale, Pache-bale* and *Chander-bale*, were used in the present studies. Some relevant data collected on a few typical lots of the ripe fruit of these varieties are given in Table I. The usual A. O. A. C. (1950) methods of analysis were employed.

Preparation for Canning. The fruit was peeled with hand and cut transversely into slices of ½ to ¾ inch thickness, with stainless steel knives.

Bigger pieces of about 2 inches long and small sized whole fruits (3-4 inches) as such after peeling, or cut lengthwise into halves, were also used in some packs.

Pre-treatment. The fruit was canned as such, as well as after treatment in $CaCl_2$ solution (2.5 per cent.) and lime water (saturated, clear solution of calcium hydroxide) for different periods

varying from 15 to 45 minutes. The fruit after treatment in lime water was rinsed in 0.05 per cent. citric acid solution.

Table I—Analysis of Ripe Bananas

Analysis Factor	*Variety Pachebale*	*Variety Rasbale*	*Variety Salem-bale*	*Variety Chanderbale*
Wt. of 1,000 fruits (lb.)	280	100	160	195
Wt. of peels (lb.)	100	20	40	70
Proportion of prepared (peeled) fruit %	64·3	80·0	75·0	64.1
Analysis of pulp.				
Reducing sugar %	6·3	10·4	11·4	—
Total sugar as reducing	15·8	19·0	18·6	—
Total soluble solids by refractometer %	18·0	22·0	22·5	25·0
*p*H	5·3	4·7	4·5	4·8
Acidity (as malic acid) %	0·31	0·42	0·50	—
Ascorbic acd mg. %	2·0	6·7	8·2	3·5

Canning Syrup. Cane sugar syrup of concentrations from 20 to 75 * per cent., and inverted sugar syrup of 80° Brix, were used as the liquid canning medium. In some solid packs, crystalline cane sugar and in salad packs, orange syrup were also used. The *p*H of the fruit being rather high, citric acid was added to the canning syrup to bring down the *p*H of the packs.

To determine the amount of acid required to be added, sugar syrup was acidified to different levels from no acid to 0.50 per cent. Banana slices and acidified sugar syrup were mixed in a waring blendor in the ratio † of 2 : 1, and *p*H of the resultant mixture was determined in each case with a glass electrode. Results are presented in Table II. Final packs, to determine the maximum palate tolerance limit, were prepared using canning syrup containing 0.15, 0.2, 0.25, 0.30, 0.40 and 0.50 per cent. citric acid. In one lot, 1.0 per cent. calcium chloride was added to the syrup to find the effect on texture and appearance of the canned product. Amyl acetate (0.01 to 0.05 per cent.) and a banana essence (0.05 to 1.0 per cent.) were also added separately to the canning syrup to see if the flavour of the canned product could be improved.

Table II—Addition of Citric Acid to the Canning Syrup to bring down the pH of the Canned Product

Citric Acid added to Syrup %	*pH of the Mixture of Fruit and Syrup (in the ratio of 2:1)*
0·00	4·80
0·05	4·70
0·10	4·65
0·15	4·52
0·20	4·40
0·30	4·30
0·40	4·15
0·50	4·00

** 75 per cent. sugar syrup was prepared by taking sugar and water in the ratio of 3:1 and bringing the mixture to a boil to dissolve the sugar. The boiling hot syrup obtained was added immediately to the fruit in the cans.*

† In actual canning experiments, fruit and syrup were packed in the ratio of 3:2. In the preliminary tests to determine the amount of acid required to be added to syrup, the fruit and syrup were taken in the ratio of 2:1 to allow for a safe margin.

Filling and Syruping. The fruit after peeling was found to discolour and become brownish if kept exposed. This was found to be due to a strong oxidase action. In the preparation of canned packs, therefore, the fruit slices were cut immediately after peeling, put directly into the cans and covered with hot syrup in the usual way. Plain tin cans of sizes 1 lb. short (301 × 309), A2½ (401 × 411) and 1 lb. squat form (401 × 300) were used in these experiments. Amount of fruit packed in each of these cans was 8 oz., 20 oz., and 12 oz. respectively. Enough canning syrup was added to fill the cans within about ¼″ headspace. This gave roughly a fruit syrup ratio of 3 : 2 in the final packs.

Solid packs in 1 lb. short cans were prepared with 11 oz. fruit and 1-2 oz. syrup of concentrations from 60 to 80 per cent. (sucrose or invert sugar), and containing 0.2 per cent. added citric acid. Sugar syrup in some packs was replaced with 1 oz. crystalline sugar.

Exhausting. The filled cans were exhausted as usual in boiling water to get a temperature of about 175°F in the centre of the cans. It took about 5, 8 and 7 minutes respectively, in case of 1 lb. short, A2½ and 1 lb. squat cans to attain the above temperature.

Processing. Processing temperature employed ranged between 207°F (Boiling point of water at about 2,700 ft. altitude, at Mysore) and 240°F. Normally, fruits are processed in boiling water (212°F). Processing temperatures higher than this were employed in these studies because in some cases the quantity of acid added was not enough to bring the *p*H below the border line value of 4.5. Times of processing employed ranged between 15 and 45 minutes, for different temperatures and can sizes. After processing, the cans were cooled as usual in running cold water.

Testing and Examination of the Canned Product. The canned product prepared under each of the treatments employed in these studies was stored at room temperature (25-30°C) and tested periodically during a storage period of over one year, by the cut out technique of Hirst and Adam (1932). Incubation tests of the product prepared by the method finally evolved and as recommended in this article, were carried out at 37° and 50°C for 6 weeks. Microbiological examination was also conducted to test the sterility of the packs.

Results and Discussion. Due to the presence of tannins in the fruit, the peeled and cut fruit darkens if allowed to come in contact with iron. It is, therefore, very important to avoid iron from all equipment coming in contact with the fruit. To prevent enzymic discolouration, the peeled and cut fruit should be immediately put in the can and covered with hot syrup. This is not difficult in commercial practice where the entire canning process is a continuous one.

Sugar syrup of 25-30° Brix (i.e., about 5° higher than the soluble solids content of the fruit pulp), acidified with 0.15 to 0.2 per cent. added citric acid, is regarded as the best canning medium. No adverse effect on the natural flavour of the fruit could be detected under these conditions. With higher propor-

tion of acid, the flavour became rather unnatural. With canning syrup of higher sugar concentrations, there was no material improvement in the quality of the packs. Solid packs with regard to flavour were slightly superior to the product packed under specifications given above. At the same time, these were regarded as too sweet and also suffered from gelation and clot formation, turbidity of syrup and disintegration of fruit.

Packs of all the four varieties in 1 lb. squat and 1 lb. short cans, employing canning syrup of 0.15 to 0.20 per cent. acidity (citric acid), and processed for 15 minutes at 228°F did not show any spoilage in incubation tests carried out for six weeks at 37° and 50°C. Microbiological examination also did not reveal the presence of any spoilage organisms. Higher processing temperatures in which case the amount of acid necessary could be reduced further, produced pinkish discolouration in the product during 15 minutes process.

A process of 15 minutes in boiling water (at 2,700 ft. altitude of Mysore corresponding to about 10 minutes at sea level) for 1 lb. short cans, or 20 minutes (about 15 minutes at sea level) for 1 lb. squat cans, was found adequate, when the fresh fruit had a pH of 4.8 or less and the canning syrup an acidity of 0.2 per cent. These packs had a maximum equilibrium pH of 4.4.

Out of the four varieties used in these experiments, *Pachebale* and *Chanderbale* were found to be good canners. *Salembale* and *Rasbale* did not yield canned products of good texture and flavour, although the latter is a good table variety. When fruit of a suitable variety was used, the overall quality of the product packed and processed according to the details recommended in this article was good; the flavour closely resembled that of the fresh fruit. Results of a typical cut out test of the canned product of all the varieties after 12 months storage are presented in Table III.

Treatment of the fruit in lime water or $CaCl_2$ solution prior to canning, as also addition of $CaCl_2$ to the canning syrup, did not materially improve the quality of the final packs with regard to texture. As the texture of the packs without any of these treatments was quite satisfactory, none of these treatments is regarded as necessary in the canning of bananas. Addition of amyl acetate to the canning syrup at 0.03 per cent. was found to improve the flavour of the product and thus guard considerably against adverse changes in flavour during storage. Plain tin cans proved quite satisfactory for canning.

Canning of Fruit Salads. Banana slices canned in combination with orange segments, papaya slices and jack fruit segments, employing sugar syrups of 45°, 40° and 35° Brix, respectively gave fruit salads of good quality with mixed flavours. Orange juice, of which the Brix had been raised to 45 degrees with added sugar, when added as canning syrup for banana slices, did not give a good product, mainly due to the development of bitterness in orange juice.

Recommendations. On the basis of investigations reported in this paper, the following method is recommended for the canning of bananas both on a small and large scale.

Table III—Cut-out Data on Canned Bananas (1 lb. short plain cans) after 12 Months' Storage at 25-30°C

Variety	Vacuum (Inch.)	Drained weight		Strength of Syrup (Deg. Brix)	Appearance		Texture	Taste and odour
		Fruit (oz.)	Syrup (oz.)		Fruit	Syrup		
Pachbale	8·9	7·9	6·9	22	Normal, creamy white	Slightly turbid	Good soft texture; no fibrous peel	Pleasant taste and odour
Chandrabale	8·5	7·9	5·5	23	Normal, pinkish white	Cloudy	Fairly soft; no fibrous peel	Good taste; odour rather weak
Rajabale	9·5	7·5	5·25	24	Normal colour	Cloudy	Rough and somewhat fibry	Starchy taste; very weak odour
Rastali	6·5	7·25	5·5	26	Good colour; rough appearance	Cloudy	Fibrous; natural creamy texture completely changed	Starchy taste; odour weak and unnatural

Note—The condition of the cans in all cases was sound; there was only light feathering of the tinplate.

1. Select fully ripe but firm and sound fruit of a suitable variety.*
2. Peel the fruit by hand and cut immediately into slices of ½″ to ¾″ thickness. Contact of the fruit with iron should be avoided at all stages to prevent darkening.
3. As soon as the fruit is cut, put it in the cans. In case of 1 lb. squat cans, 12 to 13 oz. slices may be packed in each can. Fill in boiling hot syrup of 25-30° Brix, containing 0.2 per cent. added citric acid, leaving about ¼″ head space.
4. Exhaust the filled cans in boiling water for 6-7 minutes (until the temperature in the centre of the can reaches 175°F).
5. Seal the cans immediately in a double seamer and process them for 15 minutes in steam at 5 lbs. pressure (sea level); or in boiling water, if the pH of the fresh fruit is not more than 4.8.
6. After processing, cool the cans immediately in running cold water, dry and store in a cool dry place.

Summary

Banana is an important tropical fruit of India and many other countries. Investigations carried out at the Central Food Technological Research Institute, Mysore (India), revealed that banana slices can be successfully canned like any other fruit. Details of the method of canning have been standardized. To bring down the high pH of the fruit for safe processing conditions consistent with the quality of the final pack, addition of 0.2 per cent. citric acid to the canning syrup is necessary.

Acknowledgements

The authors wish to thank Dr. V. Subrahmanyan, for his keen interest in the investigation and Shri D. S. Johar for the microbiological analysis of the samples of canned bananas.

References

1. ANON., *Leaflet No.* 117, (1943). Department of Agric., Madras.
2. VON LOESECKE, H. W., *Bananas; Economic crops, Vol. I.* Interscience publishers. Inc., New York. (1949).
3. ANON., Dried Banana Products (note)—*Colonial Plant and Animal Products*, 1950, I, 237-241.
4. GUYER RICHARD, B. & ERICKSON, F. B.—Canning of Acidified Banana Puree—*Food Tech.*, 1954, VIII, 165-167.
5. BOARD, P. W. and SEALE, P. E.—Canning Bananas—*Food Preservation Quarterly*, 1954, XIV, 2—3.
6. HIRST, F. and ADAM, N. B., *The Factory Inspection of Canned Fruits.* The University of Bristol Research St., Campden, Gloucestershire (1932).

* *Variety trials on a number of important varieties grown in important banana growing regions of India are in progress and will be reported elsewhere in due course.*

RESEARCH NOTES

The Effect of Stock-Scion Combination in the Custard Apple

THE CUSTARD APPLE (*Annona squamosa*) is a popular dessert fruit which grows almost wild up to an elevation of 3000′ in Ceylon. It is abundant in the coastal dry areas, and very good quality fruits are often found in the market during the season. In 1941 an experiment was laid down at the Experiment Station, Peradeniya, to study stock-scion relationships in custard apple. The scion material was obtained from Gampaha from a selected parent and the method of propagation used was 'patch budding'. The stock materials were *Annona squamosa* (Custard apple), *Annona reticulata* (Bullock's heart), *Annona muricata* (Sour sop), and *Annona palustris* (Alligator apple or Pond apple).

A. squamosa on A. squamosa. The plants showed high grafting affinity and vigorous growth in the early stages. There was a gradual decline in vigour after about five years. Defoliation and die-back started; ten plants out of eighteen were dead in 1949 and by 1952 all were dead. No stock over growth was noticed. The yield was fair but the fruits were too seedy with little pulp attached to them. The mean weight of fruit was 1/8 lb. Though there was absolute compatibility in the early stages the trees were short-lived as compared to seedlings and budgrafts on bullock's heart stock.

A. squamosa on A. reticulata. Plants showed great grafting affinity and vigour, but were difficult to transplant owing to the paucity of lateral roots. Once established they grew well and only six out of eighteen showed symptoms of decline in 1952. The fruits were less seedy with more pulp which was hard and granular, and the mean weight was ¼ lb. They had better storage qualities than fruits on custard apple stocks. A very slight stock overgrowth was noticed on the trees.

A. squamosa on A. muricata. Incompatibility was observed from the start. The 'bud take' was poor; the scions grew for a short period and died off within six months.

A. squamosa on A. palustris. The 'bud take' was fair but the scion shoots died off at different growth lengths. The maximum reached was about 18″.

E. P. BUELL.

DEPARTMENTAL NOTES

Development of the Cacao Industry in Ceylon

(Address given by Mr. A. V. Richards, M.Sc. (Calif.), B.Sc. (Lond.), Dip. Agric. (Cantab), A.I.C.T.A. (Trinidad), Horticultural Officer, Department of Agriculture, Peradeniya, to the Kurunegala P. A., on Saturday, November 27, 1954.)

CACAO is one of the major commodities of the world trade for which there has been a steady increase in demand in recent years. The total word production, which has fluctuated from about 625,000 to 785,000 metric tons in recent years, has however been unable to keep pace with the demand, and as a result there have been spectacular increases in the price of this commodity which a few months ago reached a peak of about Rs. 350 per cwt. The following is a statement of the total world production of cacao during the last five years:

Crop year		*World production of Cacao in metric tons*
1948-49	..	762,900
1949-50	..	776,100
1950-51	..	785,300
1951-52	..	690,400
1952-53	..	753,800

About 67 per cent. of the total word production in 1952-53 and the preceding ten years was from countries in Africa, 32 per cent. from America and only 1 per cent. from Asia and Oceania. The largest producer of cacao was the Gold Coast with 248,000 metric tons amounting to 32.9 per cent. of the total world production, followed by Brazil with 14.9 per cent., Nigeria 14.6 per cent., Ivory Coast 8 per cent. and Cameroons 7.3 per cent. Ceylon and Western Samoa were the principal producers of cacao in Asia and Oceania, each producing approximately 3,000 tons or 0.4 per cent. of the total world production. The cacao industry is however threatened with extinction in Africa by the ravages of the swollen shoot virus disease which has already caused considerable damage, and in America by the spread of Witches Broom disease against which there is no effective control. It is indeed fortunate that cacao in Ceylon is free from such destructive diseases.

The actual quantity of Cacao exported from Ceylon in 1953 was 55,010 cwt. valued at Rs. 9,700,351. Of this quantity no less than 20,339 cwt. valued at Rs. 3,825,739 went to the Philippines, and 6,497 cwt. valued at Rs. 136,896 to the United Kingdom. The total exports for the six months ending June this year were 35,230 cwt. valued at Rs. 8,990,009 of which 7,103 cwt. went to the Philippines where cacao is used largely for chewing, 5,448 cwt. to Holland and 11,274 cwt. to the United Kingdom. Although Ceylon produces only a tiny fraction of the total world output of cacao she is perhaps the most important producer of fine quality cacao in the whole of Asia and Oceania, her production being over six times that of Java where cacao was introduced by the Dutch in the early years.

It was also the Dutch who introduced Cacao into Ceylon in 1819, but it was left to the British to develop the industry on a commercial scale from 1878 onwards when the first consignment of 10 cwt. of cured cacao was exported. Since then the acreage under cacao has increased to a great extent particularly in the Kandy and Matale districts which contain about 55 per cent. and 33 per cent. respectively of the total acreage. The productive acreage under Cacao is estimated to be about 19,700 acres in the Ceylon Year Book for 1952-53, but with the large scale underplanting of marginal rubber areas in cacao in recent years the total extent is probably not less than 50,000 acres.

Climate and Soil—Cacao grows well in sheltered situations at an elevation of 500 to 2,000 ft. with a fairly well distributed rainfall of not less than 60 inches per annum and temperature not below 60°F. It is able to stand drought to some extent under shade in the Dumbara Valley but prolonged dry spells depress yields and cause dieback. Excessive rainfall and long wet spells are also harmful since they favour the spread of Phytophthora disease which attacks the pods and main stems and make it difficult to cure the beans properly.

Deep alluvial soils of high fertility which are well drained are the best for cacao. They should be rich in humus, free from high acidity and contain fair amount of calcium, magnesium, iron, zinc, and other trace elements in available form. Trace element deficiencies are believed to be responsible for the occurrence of sickle leaf disease and other nutritional disorders on cacao in the Dumbara valley. Excess of certain elements such as potash may also interfere with the absorption of magnesium and other essential elements.

Cacao varieties.—The variety of cacao originally grown in Ceylon, consisted almost entirely of the Criollo Cacao which produces plump beans, nearly white in colour when cut and cinnamon coloured when cured. With the subsequent introduction of the more vigorous Forastero types producing small flat beans, deep purple when cut and chocolate brown when cured, the relatively weak pure Criollo has disappeared, and the cacao now produced is an admixture of Criollo and Forastero which is not unlike the Trinitario Cacao of Trinidad. The beans are fairly plump, purlpe in the pod and red-brown when cured.

Both Criollo and Trinitario produced the so-called 'fine' cacaos of commerce which constitute 5 to 10 per cent. of the total world production. They are used for flavouring the ordinary or bulk cacao produced by the

Forastero Types which amount to 90 to 95 per cent. of the world's supply. The fine quality cacao produced in Ceylon commands a premium which however is not high enough to justify the sacrifice of yield for quality. Moreover recent improvements in processing technique make it possible for manufacturers to produce chocolate of reasonably good quality from ordinary cacao. The emphasis has to be therefore more on the various factors, both hereditary and environmental which influence yield than on quality provided the latter is reasonably good. Improvements in yield are possible by the use of high yielding local and imported clones, manuring with balanced fertilizer mixtures and organic manure to correct nutritional disorders, improved cultural practices such as pruning, mulching and shading, and effective control of pests and diseases.

Local Selections.—Good progress has been made in the selection of high yielding trees at Kundasale and elsewhere, and individual yield records are being maintained in respect of over 90 trees of which 9 were selected tentatively in 1952/53. Many of these trees have consistently yielded over 100 pods each year for the last two years and have a potential yield of over a ton of cured cacao per acre after making due allowance for spacing, border effect, tree size, freedom from pests and diseases, pod size, &c. One tree in particular which is of the Amelanado type has yielded 230 pods in one year and 359 in the following year. Further tree to tree surveys are being made to locate trees which yield regularly over 100 pods per season and show pod values of 8 or less, the pod value being the number of pods to a pound of cured cacao assuming a loss of weight of 63 per cent. in curing. Careful studies of the performance of the tentatively selected trees have to be made over a period of five years or so before final selections are recommended.

Imported Clones.—Meanwhile excellent progress has been made in the introduction of selected high yielding clones from Trinidad, West Africa and New Guinea after a satisfactory period of quarantine at Kew and Heneratgoda. No less than 20 of the best Trinidad clones consisting of I.C.S. 1, I.C.S. 6, I.C.S. 8, I.C.S. 16, I.C.S. 25, I.C.S. 39, I.C.S. 40, I.C.S. 45, I.C.S. 60, I.C.S. 84, I.C.S. 89, I.C.S. 95, I.C.S. 98, N.A. 32, N.A. 33, N.A. 34, P.A. 7, P.A. 35, I.M.C. 60 and Herrania species have been successfully raised from bare root cuttings received by air freight. In many of these clones less than 7 pods yield a pound of cured cacao but it remains to be seen whether their performance would be equally good if not better under local conditions. The New Guinea selections consist of 8 of the best from Keravat cacao experiment station which are reputed to yield from 15 to 18 pounds of cacao per tree, the average yield in Ceylon being only about a pound of cacao per tree. The West African Amelanado is a highly productive variety of cacao which is recommended in Malaya for cultivation in village holdings since it breeds true from seed. It produces the ordinary bulk cacao of commerce for which there is a good demand.

The high yielding clones are propagated vegetatively as rooted cuttings or budgrafts on seedling cacao rootstocks. A suitable technique has been developed for the propagation of cacao from stem and single leaf cuttings in inexpensive cloth covered propagators in which there is provision for water to drip continuously and saturate the air inside with moisture. The best rooting medium is a mixture of coir dust and fibre which holds the roots in position when develop.

Under favourable conditions the cuttings strike root in three to four weeks and are potted in baskets and gradually hardened inside the propagator by reducing the water supply and allowing more light and air into the propagator. The difficulty however is to establish the rooted cuttings in the field, since they require careful nursing. Attempts to supply vacancies in old cacao with rooted cuttings have not been successful owing to heavy casualties caused by drought in spite of hand watering. Seedlings of comparable age grown from seed sown at stake showed greater resistance to drought. But it is feasible to establish these rooted cuttings in newly opened areas which have adequate primary and secondary shade. The plants have to be hand watered during dry spells until they become well established. Their low branching habit of growth is not so satisfactory as that of the budgraft which

is more easily raised in the field by planting seed at stake during the rainy season and budgrafting the seedling stocks *in situ* the following year with compatible clonal budwood. Genetic variability is reduced to a minimum by using varieties such as the Amelanado which breed nearly true to type from seed.

Manuring.—Cacao responds to application of compost and other organic manure, particularly well rotted cattle or pig manure. The leaf fall from both the shade trees and cacao should be allowed to remain as a mulch under the trees and later become incorporated as humus into the soil. It is estimated in Trinidad that a crop of 500 lb. of cacao per acre removes from the soil as much as 12 lb. of Nitrogen, 6 lb. of phosphoric acid and 9½ lb. of potash. These nutrients have to be replaced by judicious manuring. Cacao at Kundasale has shown a striking response to application of phosphates in the manurial trials now being carried out there. There is some indication that potash has caused a depressing effect on the yield. The soils are sufficiently rich in potash which in excess is believed to cause the sickle leaf disease that occurs so widely in the Dumbara valley. On the results of this trial the manurial programme which provided for an application of 100 lb. sulphate of ammonia, 200 lb. saphos and 125 lb. muriate potash per acre at Kundasale has been tentatively modified by the chemist and only phosphates are being applied at the rate of 2 lb. per tree of a mixture consisting of ½ lb. superphosphate and 1½ lb. saphosphosphate.

Pruning.—Much of the success in cacao production depends on the care and attention given to pruning which has to be done judiciously at the correct time in February-March after the main crop is harvested. Pruning should not be too drastic ; it should be done to remove all dead and diseased wood as well as pods attacked by Phytophthora. The crown of the tree should be thinned out by the removal of chupons and small unproductive fan branches to let in more light and air. Pruning has an invigorating effect and causes the production of a new flush of leaves followed by a mass of flowers all along the main stem and branches.

The shade tree should also be lopped at the correct time and allowed to produce just enough foliage to shade the cacao. Effective control of Helopeltis and other pests is said to be possible by the provision of adequate shade. In Africa capsid attack has been found to occur first in patches where the overhead canopy of shade is broken.

Underplanting of Marginal Rubber in Cacao.—Many growers are interested in the practice of planting cacao under rubber which has become popular in parts of Matale, Galagedera, Moneragala and Passara. The pioneer in this field was Mr. Atkinson of Kepitigalla Estate who planted cacao under rubber to increase the atmospheric humidity of the understorey and thereby promote the early renewal of bark on the tapping panel and stimulate the flow of latex. Not only has this object been achieved but the cacao itself has grown well and produced a subsidiary crop. Weed growth is kept well under control by the accumulation of a thick mulch of leaves under the cacao. The success of this practice however depends on the intensity of shade provided by the rubber, the inherent fertility of the land, the distribution of rainfall, and other factors such as weed competition, incidence of root diseases and pests, &c.

At Kepitigalla cacao has failed to grow under certain rubber clones which provide heavy shade by forming a thick overhead canopy. Excessive rainfall of over 100 inches in wet areas is also detrimental to cacao. The failure under rubber in Malaya and New Guinea is probably due to the heavy rainfall there. But in those marginal areas in Ceylon where the rainfall is not excessive the growth of cacao under rubber is certainly vigorous and promising.

Diseases and Pest Control.—The major disease of cacao in Ceylon is Phytophthora which attacks the main stem and branches as well as the pods in various stages of maturity. The disease is particularly severe in wet areas but can be kept well under control by prompt treatment of the affected trees in the early stages. Spraying with copper fungicide is effective. One combined spray with a suitable insecticide such as D.D.T. may be necessary for the control of

both Phytophthora and Helopeltis which is the major pest of cacao in the Dumbara valley. The pest attacks both the young flush as well as the cherelles and pods causing dieback of shoots and wilting of the cherelles. Numerous black spots appear on the attacked pods and these provide points of entry for the Phytophthora disease which causes pod rot although a good number do ripen and provide sound beans in spite of the pest attack.

Organisation for Cacao Research.—Research on cacao has been in progress in Trinidad since 1931 when the Cacao Research Scheme was first inaugurated at the Imperial College of Tropical Agriculture. The scheme was originally financed by the cacao and chocolate manufacturers in the United Kingdom but since 1947 it has been financed jointly by the British Government and the Cacao, Chocolate and Confectionary Alliance of London, and administered and directed by the College authorities. The full-time graduate staff consists of two plant breeders, two plant physiologists, two soil chemists, one biochemist, one entomologist, one pathologist and two field officers besides the professors and senior lecturers of the college staff who were closely associated with the scheme since its inception. A similar research institute for cacao exists at Tafo in West Africa.

It is only just over a year ago that research on cacao received serious attention in Ceylon with the appointment of a Departmental Cacao Research Committee consisting of the Assistant Director of Agriculture (Technical), Chairman, the Chemist, Entomologist, Plant Pathologist, Botanist and the Horticultural Officer who was made responsible for the supervision in addition to his duties of all investigational work at the Cacao Research Station, Kundasale, which may be regarded as the nucleus of the Cacao Research Institute of the future. The experience of other countries indicates that it is by team work that much progress can be achieved in the solution of the various problems relating to the cultivation and production of cacao, and the progress made so far, with the limited staff and facilities at our disposal augurs well for the future.

Speech by the Hon. J. R. Jayewardene, Minister of Agriculture and Food, at the All-Ceylon Stock Breeders' Show, Negombo, on March 4, 1955

It gives me great pleasure to declare open this Show organised by the All-Ceylon Stock Breeders' Association. I also wish to extend a warm welcome to Sardar Mabadur Sir Datar Singh who has come over from India to judge the exhibits. We are all extremely grateful to him for having found the time in spite of his multifarious duties to come so far to assist us.

It has been the custom among all developed countries engaged in agriculture to foster and develop livestock industry. Our early ancestors also elevated the cow to the position of sanctity it has occupied among the Indian people. Unfortunately, due to the disruption of our agricultural systems in the last three centuries in particular, livestock development had not been carefully attended to or, if fostered, was carried out only at brief intervals. In the last few years the Government has been able to focus the attention of the general public to this important part of agricultural development, and has responded to the demands of the livestock associations in actively assisting and planning out the development of animal husbandry in the Island.

The Department of Agriculture has expanded its extension services by the creation of a large number of posts of Veterinary Surgeons to cover almost every district by introducing artificial insemination centres, and actively engaging in research and production of stock. We always welcome and encourage the utilisation of the Department's services by members of the public and it is heartening to see the response among agriculturists in every district.

A Milk Board has recently bee established to co-ordinate the production, distribution and sale of milk, and when it starts its operations there is no doubt whatsoever that the pace of development will be accelerated.

The Food Production Department has formulated a scheme to give relief to estate

owners under the Food Production Ordinance in cases where they are actively engaged in planned livestock development. I hope that those among you who have the good fortune of owning estates would, both in your own interests and of the nation at large, avail yourselves of the opportunities afforded by this scheme.

In the interests of the younger generation, in whose hands the responsibilities of the future will lie, and from whom the Government expects a lead in agricultural activity, we have set up a network of Young Farmers' Clubs by which their activities could be co-ordinated, and through which the requisite technical information could be disseminated. It is heartening to see the enthusiasm with which these Clubs are being supported and the perceptible improvements that have been brought about.

There are two problems pertaining to livestock development which I would like to stress. Firstly, I would like to impress upon all of you here that Government can encourage and direct, but organised and sustained effort should come from the people. In proper care and maintenance, in correct breeding and in organisation for the marketing of your produce, we expect a great deal of initiative from you. It is sometimes tragic to note the almost inhuman neglect of animals in this country, especially in the case of cattle. It is no excuse to say that there is no pasture land available. Against this I can mention the example of cattle belonging to labourers of estates, and examples of genuine animal lovers in various parts of the Island where, even at great inconvenience to themselves, the owners have fed and maintained animals on fodder grass.

Secondly, I would like to urge on owners of cattle the need for correct branding of animals. There is no doubt that a large percentage of hide produced in Ceylon is completely useless due to improper branding. Correct thigh branding has always been urged by the Department of Agriculture and we hope that cattle breeders, wherever possible, will help to propagate this requirement.

I hope that when the next Show is held the All-Ceylon Stock Breeders' Association would have gone on from strength to strength and embraced through its affiliated societies in each district the whole Island in the scope of its work, and that Co-operative Milk Production and Sales Societies would have sprung up to serve the interests of the genuine livestock breeders.

It is very encouraging to see that the Show is being held in a rural area, and that too in one where exist some of the most enthusiastic agriculturists in Ceylon. Your Organizing Committee and your energetic President, Mr. Clement Dias, deserve our special congratulations on the success of the Show.

The Contribution of the Department of Agriculture to Animal Husbandry Development in the Island

A Review by Dr. A. W. R. Joachim prepared for the All-Ceylon Stock Breeders' Show, Negombo, on March 4, 1955

WITH THE amalgamation of the erstwhile Veterinary Department with the Department of Agriculture in 1936, when the late Mr. D. S. Senanayake was Minister of Agriculture and Lands, a planned programme for the development of animal husbandry was drawn up by Mr. Edmund Rodrigo, then Director of Agriculture, with the advice of Dr. M. Crawford, Deputy Director (Animal Husbandry) and Government Veterinary Surgeon, and considered by a Special Committee of the Central Board of Agriculture. This Special Committee's report together with a memorandum from the Director of Agriculture was published as Sessional Paper 5 of 1938. Many of the recommendations of the 1938 report were given effect to by Mr. Rodrigo and by Messrs. L. J. Seneviratne and D. Rhind who succeeded him. These related particularly to the establishment of farms in different parts of the Island for the breeding of suitable types of livestock, the training of personnel abroad and the intensification of extension activities in animal husbandry through the agency of veterinary officers and agricultural instructors under the direction of divisional agricultural officers. Such activities included the establishment of stud centres, the castration of scrub bulls, the issue of poultry and eggs to breeders and villagers for grading up their stock, the issue of planting material of

fodders and pasture grasses, innoculation against Raniket and other diseases, the establishment of dairy units on all school farms to serve as demonstration centres to students and the public, &c.

In 1945 Dr. Norman Wright, Director of the Hannah Dairy Research Institute in the U. K., was invited by the Ceylon Government to advise on measures which had been adopted or were contemplated for expanding the production of milk in Ceylon and, in particular, on the desirability of increasing the importation of European types of cattle and establishing dairy farms. In his valuable report published as Sessional Paper 20 of 1945, Wright pointed out some of the deficiencies in the then existing organization for the development of animal husbandry in the Island and how these could be remedied. One proposal which resulted from his report was the appointment of a Specialist in Animal Husbandry in the person of Mr. C. R. Turbet to take unified control of the five major animal husbandry farms which were then being developed. Turbet served in this capacity till 1949 and his report on the Development of Cattle Farms published as Sessional Paper 2 of 1949, is a useful record of the development of these farms and the problems confronting the pioneers in this field of work, and offers helpful suggestions for their efficient management. One serious criticism which Wright made was the lack up to then, of any fundamental research in animal breeding. This was soon rectified. Dr. P. Mahadevan, Livestock Research Officer, was sent out for specialized training in this important aspect of animal husbandry, and the valuable work he has done since his return in analysing the genetic structure of our cattle and poultry populations and in carrying out suitable breeding programmes and experiments for improving their productivity by such methods as progeny-testing of sires, selection of high yielding cows and cross-breeding, is the strongest justification for Wright's criticism.

Turbet was followed by the present holder of the office, now designated General Manager of Farms, Mr. A. V. Anker, who with his wide academic training and practical experience of dairying in Denmark has achieved remarkable success with the management of the ten animal husbandry farms now under his control. Although the primary object of most of these farms is the breeding of livestock suited to the area for issue to breeders or for grading up indigenous stock, it is gratifying to record that nearly all of them are giving an income in excess of expenditure. The income is derived mainly from the sale of milk, livestock and eggs. Last year over 374,000 gallons of milk were supplied to hospitals and milk feeding centres from these farms, and 691 head of livestock were issued in one way or another for breeding purposes. It would be interesting to state here that the total sales of milk from all Departmental farms in 1954 amounted to 416,600 gallons of cows milk and 61,270 gallons of buffalo milk.

Within the past few years there has been under the direction of Mr. Dudley Senanayake, Sir Oliver Goonetilleke, and the present Minister of Agriculture and Food, Mr. J. R. Jayewardene, an intensification of the programme of animal husbandry development drawn up against the background of Norman Wright's report and on the suggestions of Mr. H. Hirst, F. A. O. Adviser in Animal Husbandry from 1951 to 1953. These activities are under the general supervision of Dr. T. M. Z. Mahamooth, Deputy Director of Agriculture (Animal Husbandry) and Government Veterinary Surgeon. Some of the advances made are as follows :—

1. The staff concerned with animal husbandry has been appreciably increased. A fairly large number of officers have been sent abroad for training and are now manning various animal husbandry units and extension activities. Further increases in the field staff will be necessary to promote adequate extension activities in animal husbandry.

2. A clear-cut policy has been laid down for each of the major animal husbandry farms. These are briefly as follows :—

(i) Bopatalawa : to breed cattle of European breeds, particularly Friesians and Jerseys, for the purpose of supplying breeding stock and to carry out investigations on breeding, feeding, dairy

management, and fodder production under prevailing conditions.

(ii) Ambawela: as for Bopatalawa but with Aryshire cattle.

(iii) Polonnaruwa: for pure-bred Indian breeds of cattle and goats and to establish pasture and fodder suited to dry zone conditions.

(iv) Ridiyagama in the Tangalle District: to breed Murrah buffaloes, to conduct cross breeding experiments with local buffaloes, and to meet the local demand for stud animals.

(v) Nikaweratiya: to breed pure-bred draught cattle of Indian breeds, viz., Khillari and Kangayam.

(vi) Karagoda-Uyangoda to conduct breeding experiments with Sinhala cattle for improving the milking capacity of the breed.

(vii) & (viii) Narahenpita and Welisara: to be run as commercial dairies until they are taken over, when needed, by the Milk Board.

(ix) Undugoda in the Kegalle District: now run as a dairy, is likely to be utilized as a centre for rearing bull calves.

(x) Ambepussa Farm: has been the chief poultry breeding centre, and will be utilized for dry cows and heifers. A new poultry centre has been started at Karandagolla on the Kundasale cacao estate where conditions are more favourable than Ambepussa for poultry.

3. A scheme of exchange of bull calves has been introduced with the ultimate object of grading up local animals and incidentally eliminating useless scrub bulls on the principle that a bull calf of improved breed will be exchanged for local scrub animals more or less on a weight for weight basis. A similar scheme is in operation in regard to the improvement of poultry in villages. All extension activities are co-ordinated in the Animal Husbandry Division by the Livestock Officer, Mr. W. D. E. Perera.

4. A large number of stud centres have been established. These are either under departmental control or are run by private parties. The latter have been subsidized at the rate of Rs. 15 per mensem per stud bull. There are 235 stud centres at present in the Island of which 123 are under the control of the Department. These carry 405 stud bulls and 116 stud goats. Recently a drive to intensify the cattle up-grading policy in localized areas was started in the Kegalle District. The Department gave the Revenue Officer such assistance as was possible in the pursuance of this objective.

5. A small milk collecting scheme was started at Polonnaruwa in March last year in order to encourage producers to market their commodity. The milk is pasteurized and supplied to milk feeding centres. With the establishment of the Milk Marketing Board this work will come under the control of the latter.

6. Encouragement was given to the formation of district Livestock Breeders' Associations in different parts of the country. There are now seven such associations. It is pleasing to record that the Stock Breeders' Association of Ceylon which was started in 1938 with the fullest support of the Department of Agriculture had in its earlier years the Director of Agriculture as its President.

7. Considerable success has met the Department's efforts to find suitable varieties of pasture and legumes for forage purposes. Molasses grass (*Melinis minutiflora*) for the wet zone, and *Brachiaria brizantha* for the wet and dry zones have proved to be very successful species. The legume *Stylosanthes gracilis* (Queensland lucerne) has been found useful in many parts of the country.

8. Twenty-one artificial insemination centres have been established in various parts of the country. The rates charged for services are low in order to popularize the practice. More units will be started as the need arises.

9. Poultry production was given a fillip by the start of a backyard poultry scheme in Colombo and the introduction of the deep litter system at a number of schools. The campaigns for vaccination against poultry diseases have been intensified. The number of eggs produced and issued from our farms last year for hatching purposes was 79,000 approximately.

10. Intensive work has been organized on the nutritive value of home-grown feeding-stuffs. Digestibility trials with cattle and

statistically designed feeding experiments with poultry and cattle are now well under way and the results therefrom should prove economically beneficial to local farmers.

11. The work on disease control under the direction of Dr. P. G. Malkani has made considerable headway and that on goat paralysis by Dr. C. Perumalpillai is noteworthy. The personnel of the Veterinary Research Laboratory has been increased very appreciably, and the laboratory now manufactures nearly all the vaccines it requires. Approval has been obtained for the inclusion in the next five-year programme of a sum of Rs. 1.4 million for the establishment of a new veterinary research laboratory and hospital, &c.

It will be agreed that in Ceylon our animal husbandry activities should be directed mainly to the production of milk, which at present is deplorably low. This has been largely due to the lack of suitable marketing facilities. There is little doubt that with the establishment of the Milk Marketing Board this defect will be remedied and there will be a rapid increase in the production of this valuable food in the country. Incentives offered to estates under the Food Production (Estates) Act will also contribute appreciably towards the greater production of milk and other animal food. With the facilities now offered by the Department of Agriculture and the Milk Board, and with the steady availability of trained personnel from the Ceylon University and other sources, there is no reason why considerable advances should not be made in the next few years in the intensification, promotion and development of animal husbandry in the Island.

CENTRAL BOARD OF AGRICULTURE

PROCEEDINGS OF THE EIGHTH MEETING OF THE CENTRAL BOARD OF AGRICULTURE HELD AT THE SCHOOL OF AGRICULTURE, PERADENIYA, ON JANUARY 21, 1955, AT 2.30 P.M.

Mr. C. A. M. de Silva, Vice-Chairman, presided till Dr. A. W. R. Joachim, Director of Agriculture and Chairman, arrived a few minutes later as he had to meet the Australian Prime Minister at the Royal Botanic Gardens, Peradeniya.

The following members of the Board were present :—

Mr. N. Manicka Idaikkadar, C.C.S., Director of Food Production ; Mr. S. Arumugam, Assistant Director of Irrigation ; Gate Muhandiram Arthur D. S. Jayasinghe ; Mr. R. T. Chelliah ; Sir J. P. Obeyesekera ; Mr. S. C. Fernando, C.C.S., Commissioner of Co-operative Development ; Mr. W. M. Cumarasamy ; Gate Mudaliyar N. Wickremaratne ; Dr. H. E. Young, Director, Rubber Research Institute ; Mr. S. Pathmanathan ; Mr. R. H. de Mel ; Mr. D. G. Dayaratne, C.C.S., Director of Rural Development ; Mr. S. L. Bandara Dharmakirti ; Mr. S. A. Selvanayagam, O.B.E. ; Mr. J. A. de Silva, Conservator of Forests ; Mr. P. B. Bandaranayake, D. R. O. ; Mudaliyar N. M. Abulcassim Maraikar ; Mudaliyar S. Armstrong ; Mr. J. M. Saharatnam, D. R. O. ; Mr. A. Divitotawela ; Mr. A. W. R. Perera, Assistant Commissioner for the Development of Marketing ; S. A. I. Elapata Dissawa ; Mr. A. D. Paranavitane ; Mr. C. Wijesinghe ; Mr. C. J. Strachan ; Mr. M. B. Samarakoon, D. R. O.; Major E. C. de Fonseka, M.B.E., E.D. ; Mr. F. A. Wickramasuriya ; Mr. Ray Wijewardena ; Mr. Anton C. Ponnampalam ; Mr. H. A. Pieris and Mr. N. P. Wijeyeratne, C.C.S. (Secretary).

The following visitors were present by invitation :—

Mr. C. J. Serasinghe, C.C.S., A. G. A., Nuwara Eliya ; Dr. D. T. E. Dassanayake, Director of Meteorology ; Dr. K. Ramiah, F. A. O. ; and Professor Evan A. Hardy, F. A. O., Technical Assistance Mission.

The following officers of the Department were also present :—

Dr. T. M. Z. Mahamooth, Deputy Director (Veterinary Services) ; Mr. C. N. E. J. de Mel, Deputy Director of Agriculture ; Dr. W. R. C. Paul, Assistant Director of Agriculture (Technical) ; Dr. M. F. Chandraratne, Chief Research Officer ; Mr. A. V. Richards, Horticultural Officer ; Mr. D. M. Ratnatunga, Chief Agricultural Engineer ; and Mr. T. Wickremesinghe, Soil Conservation Officer.

Letters and telegrams regretting inability to attend were received from the following :—

Mr. T. B. Naranpanawa, D. R. O. ; Mr. K. Morford, C.B.E. ; Mr. Gladwin Kotalawala, M.B.E. ; Mr. A. Hensman ; Mr. Albert Godamune ; Mr. V. G. W. Ratnayake, M.P. ; Mr. A. M. Clement Dias ; Mr. H. S. Hurst ; Mr. T. C. Rajaratnam, C.B.E. ; Mr. G. K. Newton ; Mr. S. Pararajasingam ; Mr. M. Atkinson ; Mr. J. Lamb, Director, Tea Research Institute ; Sir Wilfred de Soysa ; Mr. A. F. R. Goonewardena ; Mr. N. H. Keerthiratne, M.P. ; Senator Justin Kotalawala ; Senator Lady Molamure, O.B.E. ; Mr. U. B. Dedigama ; Mr. Vernon Rajapakse ; Mr. Marcus Rockwood ; Mr. N. R. Rajavarothiam, M.P. ; Senator Thos. Amarasuriya ; Sydney Ellawala Dissawe ; Mr. M. Senanayake, M.P. ; Mr. Henry Abeywickrema, M.P.; and Mudaliyar M. M. Ebrahim, M.B.E., M.P.

I—Confirmation of the Minutes of the last Meeting

The minutes of the previous meeting of the Central Board of Agriculture were unanimously confirmed.

II—Resolution moved by Mr. Ray Wijewardena

The Chairman read the resolution to the Board and requested Mr. Wijewardena to formally move it.

Mr. Ray Wijewardena—"Mr. Chairman and fellow agriculturists—You will all, I feel certain, agree with me that the importance of this Board makes it essential for as much business to be conducted at every meeting as is humanly possible.

This goal can only be achieved if we all endeavour to restrict our proposals, comments and discussions to the most essential points and thus say in five words what might otherwise take us fifteen or more. Business organizations throughout the world have found that the placing of a time limit upon each speaker helps tremendously to achieve very much more results in very much less time. Prompted by a sincere desire for this Board to achieve the very fine objects for which it was created I now formally propose a resolution :

> "THAT ALL SPEAKERS AT MEETINGS OF THE CENTRAL BOARD OF AGRICULTURE BE GIVEN A TIME LIMIT OF 15 MINUTES. UNDER EXCEPTIONAL CIRCUMSTANCES, SUCH AS IN THE CASE OF A VISITING SPEAKER OR LECTURER ATTENDING THE MEETING, THE CHAIRMAN MAY, AT HIS DISCRETION, EXTEND THE TIME LIMIT, WHICH WILL OTHERWISE BE RIGIDLY ADHERED TO"

Mr. C. A. M. de Silva in seconding the resolution said—"It was rather unfortunate that even with a warning members kept on their feet for long periods. Instead of probing into the past, which will never help the Board, I think if members were brief in all their comments much time could be saved".

Gate Mudaliyar N. Wickremaratne—"Mr. Chairman and Gentlemen—We have not come here to discuss the time limit of resolutions. We come only to discuss matters of agricultural importance to the State. May I ask what is the qualification for a Board of this nature to pass a resolution of this type and how the Chairman of the Board consented to put in that resolution in the Agenda. A previous Director of Agriculture said that we come here to listen to the views of enthusiastic members who attend meeting after meeting and to get something out of them. We cannot, therefore, restrict our comments to a time limit. I know the time when the Board of Agriculture had 30 odd members. Then it was increased to 60. And now the membership is 80 and, instead of extending the time for meetings from one to two days as the membership is greater, we are now trying to shorten the time. Last time when the meeting was held in Colombo it was only for two hours duration from 3 to 5 o'clock and these members have to come miles and miles to speak only for 15 minutes. At the rate of 15 minutes how many days does it take for 80 members to speak? The previous Minister set a good example when he said—meet in the mornings and meet in the afternoons for your meetings. If you can't provide lunch we can look after ourselves, but let us continue our meetings from morning till afternoon and afternoon till evening. I have been sitting on this Board for the last 48 years and if you pass a resolution like this I will never come before this Board again".

Mudaliyar S. Armstrong—"Mr. Chairman and Gentlemen—I strongly support Gate Mudaliyar Wickremeratne's views on this resolution. I must say, Sir, that we come here all the way from Batticaloa and from Jaffna and spend only a few hours, say two to three hours, at our meetings and I do not think it is correct to limit the time allowed to us to express our opinions because within that limited time we will not be able to express ourselves frankly on matters on which we have gathered information by our experience. Most of our members here are not scholars but are farmers, and as such, we must explain what we know by experience. I feel, Sir, and I would submit that if the house is going to restrict the time for speeches and opinions of members, our meetings should be extended for a full day instead of half a day as at present".

Mudaliyar Abulcassim Maraikar—"Mr. Chairman and Gentlemen, I heartily endorse the observations made by Gate Mudaliyar Wickremeratne on this motion. Gentlemen, we have as our Chairman the Director of

Agriculture and he can use his discretion whether a speaker is exceeding his time limit either by 15 minutes or half an hour or even a day because it depends on the importance of the subject. If a member is dwelling at length on irrelevancies, the Chairman can use his discretion and ask him to restrict his remarks. It is very unfair to limit the time allowed to a speaker to 15 minutes. It depends on the importance of the subject and if a member has to speak on a subject like paddy cultivation or food production, it is impossible to state all what you have got to say in 15 minutes. If we have to take an important decision and if members are unable to say all what they have to say in 15 minutes, it will not be possible to make a fair decision. Gentlemen, instead I would suggest to the House that the Chairman be allowed to exercise his discretion in matters more or less relating to this motion if members could undertake not to be unfair by the Chairman. We will submit to the ruling of the Chairman. If the Chairman thinks that we have been unduly long and a speaker has been holding the floor for a long time or if he thinks that a speaker's remarks are not relevant to the subject under discussion, we should submit to the ruling of the Chairman ".

Mr. M. B. Samarakoon—" Mr. Chairman, it is not quite clear whether a speaker is allowed 15 minutes for one resolution or for the whole meeting. Does it mean that during the course of the whole meeting a member can speak for only 15 minutes ?"

Mr. Ray Wijewardena replied that the intention was that a speaker should be allowed 15 minutes per speech, and he accordingly altered the resolution, with the permission of the seconder, to read " 15 minutes per speech ".

Mr. M. B. Samarakoon—" I feel that there is no necessity for us to move such a resolution by the Board and, therefore, I am also opposed to it ".

Mr. Anton Ponnampalam—" Mr. Chairman—I suggest that the resolution should stand as it is for further consideration at two or three meetings that may follow subsequently. This is the 8th meeting of the Board and it is too soon to adopt the motion without a warning so that the necessity for such a resolution could be decided at a subsequent meeting ".

Chairman—" In other words you suggest that the resolution be suspended for further consideration ? "

Mr. C. A. M. de Silva—" The Chairman will use his discretion and allow a speaker to continue if he is not deviating from his point when he is addressing the Board. But the fact is that some of these members indulge in past history. We travel from distant places to attend meetings here ".

Mr. Ashmore Peiris—" Mr. Chairman, I would like to suggest that any speaker speaking on the motion proper may be allowed to speak for more than 15 minutes at your (Chairman's) discretion, but any other person who speaks in support of that motion, either for or against, may be allowed only 5 or 10 minutes. The principal speaker may be allowed more than 15 or 20 minutes ".

Chairman—" I take it, gentlemen, that you would wish to adopt the proposal suggested by Mr. Ponnampalam that this resolution be suspended for a further meeting. I do not think myself that we have any reason to complain of people speaking inordinately long, and I would recommend that we adopt Mr. Ponnampalam's proposal and suspend this motion for consideration at some future date, if necessary ".

The house unanimously agreed to this proposal and the motion was suspended for a further meeting.

III—Resolution moved by Major E. C. de Fonseka

" THAT IN VIEW OF THE TREMENDOUS DAMAGE CAUSED ANNUALLY BY FIRE TO VALUABLE PATNA LANDS AND THE DESTRUCTION OF SPRINGS AND WATER SUPPLIES IN UPPER UVA, IMMEDIATE STEPS BE TAKEN BY GOVERNMENT TO PREVENT THIS BY—

(*a*) planting up more forests,
(*b*) establishing fire lines, and

(c) requesting Headmen, Police and other Government departments to render assistance in preventing the spread of fires."

Major E. C. de Fonseka—"I do not wish to waste time of the Board by going into elementary details of damage done to the land by setting fire to patnas, but in asking the Board to support this motion, would bring to your notice one or two points. Setting fire to patnas is not of recent origin. I came across an article in the book 'Robert Knox in the Kandyan Kingdom' in which the writer refers to the question of setting fire to patnas. The period referred to was between 1660 and 1679. Thus this practice of burning patnas has been going on continuously since 1660. The first question is why our people set fire to patnas? The second is, who set fire to patnas?, and the third is what is the best way to prevent the destruction caused to the top soil by setting fire to patnas annually?

One reason is that during the dry months the grass is very coarse and the people know that there is very little for their animals to feed on. So they set fire to patnas and after the rains the grass shoots out afresh and there is enough food for the animals. Then, there is also a belief in the villages that when they set fire to patnas it helps to produce rain. It is very strange that soon after you set fire to patnas, rain does come down. It may be a coincidence, but the fact remains that it does happen and people continue to believe the story. The second question is who are the people who set fire to patnas? As I said before, cattle-keepers are the people who set fire to these patnas. There are people who own fairly extensive herds of cattle including estate cattle-keepers, and they do a tremendous lot of damage. In the area round about Diyatalawa, patna fires are also caused by some of the Services personnel who go out for a stroll and throw their cigarette stumps into the dry grass. This is peculiar only to Diyatalawa and not to any other place.

On the question of what we can do to prevent this, I suggest the planting of more forests. Government is doing a certain amount of work in reafforestation but I feel that much more can be done in this direction. There is a tremendous demand for fuel and Government should extend their activities in this direction. Another point I would like to stress is that on patna lands there should be enough fire lines so that in the event of a fire, it will not spread throughout the entire patna. Fire lines can be in small blocks cutting up or dividing an extensive patna. This is an easy method of controlling patna fires.

Another important reaction of the people to patna fires is that they take a delight in seeing the fires spread. For them it is something like a fireworks display, because the damage is on Government property and nobody is interested or worried about it. If only the people are interested it is quite simple to put out a patna fire. You have merely to beat the fire with a big stick or brushwood. I suggest that Headmen should be made responsible for putting out patna fires in their respective areas. They can always call upon Rural Volunteers or the Police or members of other Government departments in that area to help them. I know there is a law to prosecute people who are found guilty of setting fire to patnas but I do not know whether anybody has been prosecuted so far. The damage caused is very great in Upper Uva and not so much in Lower Uva where the land is not so steep and where there are no streams to get dried up.

With your permission, Gentlemen, I would like to amend my motion by deleting the words "Upper Uva" so that the whole Island may be embraced. Incidentally I would like to tell you of my experience of patna fires. My home is completely surrounded by patnas. Every year during the months of June till August I have got to employ a special man to look out for patna fires at night. Every single year I run the risk of getting my whole homestead burnt. Two years ago a fire broke out and went on spreading and it came very close to my house. I was not at home and my wife had telephoned the Police and they had said that it was not their job to put out patna fires. The time was about 3 o'clock in the morning. She had then to telephone the Naval Establishment and within 20 minutes a party of 75 British Naval Ratings came over and put out the fire".

Mr. J. A. de Silva, Conservator of Forests —" Mr. Chairman and Gentlemen—You have heard the proposals of Major Fonseka and this problem we have attempted to solve for many years. Major Fonseka has suggested reafforestation of various lands, but this land is already classified into various land use categories. At the time these areas were mapped out it was decided which area should be reafforested, which areas should be set apart for village expansion and which areas should be set out for pasture. Each Department sets out its proposals to the Settlement Officer indicating their needs in each area. The Forest Department too sets out its proposals. As you are aware, we cannot have forests of 20 and 30 acres. We try to build up forests of at least 400 to 500 acres. Growing forest trees depend entirely upon the demand made on the land by other people. So that in order to put this resolution into effect—to plant trees on patnas—first the land must be made available to the Forest Department. Unfortunately very little land has been mapped out in Uva for growing trees. Any land which has been mapped out for forestry has been planted out. There is not an acre of land which has been given to the Forest Department which has not been planted. I have been endeavouring, in the last few years, to increase the acreage under forest. Roughly about 1.3 per cent. of the land in Uva is only in forest, except the Bintenne area in the Uva District ; this is a very unfortunate position. If I ask for the balance land, the pressure is for village expansion and pasture. In the past few years I have been attempting to formulate a scheme of how we can grow trees and tackle this question of patna fires. Merely passing resolutions like this will not carry us very far, if we want to stop fires. I formulated a scheme where we can have wind belts or shelter belts combined with pasture. When the late Mr. D. S. Senanayake visited some of our plantations I think he was a bit surprised that we made such a good job of it. We were asked to plant the rest of the live land with trees and I prepared to do it and we lost about a thousand rupees worth of barbed wire that was used for fencing. My good endeavours to reafforest patnas as suggested by Major Fonseka have not proved successful without the co-operation of the people. The only other thing is to get the land mapped out and, with the assistance of the Agricultural Department or the Food Production Department, get some money allocated to the Forest Department, to combine pasture with growing of forest trees. We have been working on this problem for some little time and I think we could do it. If we tackle the problem, I think there is some hope of stopping these fires. In each village there is a large majority who do not want to give effect to this suggestion. Unless we get the co-operation of this vast majority the scheme will not work successfully. If we start growing trees without the co-operation of the majority, it will be money going down the drain. We must be sure that we get the support of every cattle owner and that he will not violate rules and regulations and that he would follow the directions of the Agricultural Instructor.

The question of cattle food in the patnas will also have to be gone into. The present scheme is that we should plant up 300 acres with wind belts which means spending Rs. 30,000 a year. As soon as it is planted, we must get the assistance of the local population. The other cause of these fires is sheer carelessness on the part of the people. Some people are in the habit of carrying burning torches in the night and flinging them carelessly thus making fires to spread. I think the good offices of this Board must be used to ask Government to spend a little money on this scheme for forestation and pasture. The votes of the Forest Department are very little and I get hardly three lakhs of rupees a year. If you want to start a big scheme like this we will have to take at least 300 acres a year. There are about 10,000 acres of patna and you will want about Rs. 30,000 in the first year and subsequent years at least half a lakh. And any scheme that we embark on must have the goodwill of the villagers. It will be found that in these villages the cattle population is spread only among a few people. Those are the people we have to consider from an economic point of view. We cannot afford in this country to waste much of our land asset. Are these people producing sufficient milk, eggs, &c. ? If not, we can utilize that land for growing

valuable trees. What are we getting in return for leaving 10,000 acres under pasture ? How much butter and milk could they produce ? In other words it will be more economical to grow some good tea on that land. If one has 10,000 acres of tea about 10,000 labourers could be employed. That is my personal view. One must answer what is the best economic use the 10,000 acres can be put to. If you are going to put it under pasture you must make sure what returns it will bring. If there are 10,000 acres of good tea land direct and indirect taxation can bring in a good revenue ".

Mr. Tissa Wickremasinghe, Soil Conservation Officer—" Mr. Chairman and Gentlemen —I would like to make a few observations on what Major Fonseka said. Major Fonseka spoke a little while ago about the burning of patnas. Mr. J. A. de Silva, Conservator of Forests, pointed out the problem of mapping out according to the needs of the people. There is at present a very strong need for pasture for the cattle owned by people. The cattle these people maintain is not for milk but purely as a source for organic matter for the type of agriculture they pursue in these areas. If cattle are kept for meat, I think we will have to bring the lower slopes into rotational pasture and the steeper slopes into forest. The scheme suggested to have trees in pasture areas so as to provide shade for cattle is a very good one ".

Mr. A. Divitotawela—" Mr. Chairman and Gentlemen—Major Fonseka has brought out the very difficult question of stopping patna fires and we have heard Mr. J. A. de Silva's views on the matter. The people living in these areas maintain herds of buffaloes for their agriculture. After their agricultural activities are over, during a part of the year, their buffaloes are sent out to these pasture lands so that such people would find it difficult if they do not have these pasture lands. Apart from these pasture lands, surely there is enough forestry being done in Uva. As you know, now the people in Uva do not have enough cattle as they used to have in the old days and if Government were to formulate a scheme of having pasture land separately and reafforestation separately, then I think a large extent of the patnas in Uva could be reafforested. Major Fonseka has pointed out that this problem of patna fires has existed in Uva for generations but I think if the area for pasture and reafforestation is mapped out properly making enough provision for pasture, this difficulty could be overcome. Of course, villagers will not appreciate the work that Government is doing in afforestation but now I do not think they are so bad as they used to be ".

Mr. C. J. Serasinghe, A. G. A., Nuwara Eliya—" This question was considered at the Nuwara Eliya District Agricultural Committee. A sub-Committee appointed to go into the question of patna fires has submitted a report and a copy has been sent to the Secretary of the Board. The main recommendation of the Sub-Committee was that it was not enough passing legislation but it was also necessary to provide an alternative grazing scheme for the villagers. They went into the question of why the villagers burnt the patnas. It has been ascertained that it is done for the purpose of getting better pasture grass.

The Forest Department has started a scheme of wind belt afforestation in Harasbedde. There is generally no difficulty in finding land for these schemes. The Conservator of Forests explained the difficulty of obtaining land, but as far as most Revenue Officers are concerned, there is no difficulty in providing the land for this commendable purpose. In the Nuwara Eliya District, these fires occur not only on Crown land but also on private land. It is necessary to have some legislation but it is also necessary to offer the villagers with an alternative scheme. One of the first steps that should be taken to implement the scheme is to have a census of cattle population per village or group of villages together with an assessment of the patna land and then to evolve a suitable scheme to develop the areas with pasture. I have no doubt that the Central Board of Agriculture will use its good offices to get the Government to provide the necessary funds and machinery.

There is also the Soil Conservation aspect of the matter. There are the Soil Conservation regulations which are applicable to specific areas—the erodible areas. The Soil Conservation Act applies generally to the

Mahaveli Ganga catchment and upper Kelani Valley catchment. But this aspect of soil erosion applies to the areas which are eroded by the North-East monsoon as well. In fact the problem is more serious in Nuwara Eliya than in Uva because of the heavier rainfall and steeper land. Generally this problem of providing a pasture scheme exists mostly in relation to the Uva and Central Provinces. Most of you gentlemen will find that the wind belt afforestation scheme evolved will also be useful in low-country areas. One of the recommendations has been that Soil Conservation regulations should be extended to a greater extent, but I do not know to what extent the Ministry of Agriculture and Food will find the staff and funds to enforce these regulations on the people. In addition to having a plan of pasture-cum-afforestation, the Committee also recommended a certain amount of propaganda, and these were the steps they recommended :

(1) Periodically, especially before the rainy season, officers of the Forest, Revenue, Soil Conservation and Fauna and Flora Departments attend the meetings of the Rural Development Societies, Village Committees and Young Farmers' Clubs in order to explain the advantages of the Improved Pasture Scheme and the disadvantages and consequences of unrestricted grazing and fire raising, and by means of informal lectures attempt to make the villager more fire conscious by preaching the gospel of fire protection.

(2) The Education Department be requested to include in their curriculum lessons on Nature Study, Animal Husbandry, Farm Management, &c., in order to instil in the younger generation a love for the land that surrounds them and on which they depend for their existence.

(3) In the booklet 'Instructions to Headmen', a paragraph be added emphasizing that prevention and detection of wilful fire raising is a national duty. The difficulties in detection of offences are well nigh insurmountable. Nevertheless, rewards should be offered to informants and witnesses who ensure successful prosecutions. The possibility of the inclusion of the offence of wilful fire raising in the Penal Code should be explored, as it is felt that the punishment as stipulated by section 24 of the Forest Ordinance is totally insufficient as a deterrent.

(4) The Government Information Department through the Film Unit produce a documentary film illustrating the evils of patna firing and over-grazing to be shown to Schools, Village Committees, Rural Development Societies and Young Farmers' Clubs.

(5) The Department of Information conduct a poster competition for the selection, distribution and publication of the most attractive and illustrative posters in Village Halls, Resthouses, Preaching Halls, Schools, Railway Stations, &c.

Mr. Morford has been able to obtain a few posters from abroad. The problem exists in his own country too and he has been able to suggest certain ideas for the printing of posters.

(6) The Department of Information produce handbills and booklets in all the three languages for publication, outlining the principles of the Anti-Patna Firing Campaign, the gravity of their offence, the punishment, the availability of rewards to informants and witnesses, and the advantages of the Improved Pasture Scheme.

Generally the opinion of the Sub-Committee was that compulsion was only a last resort and that everything should be done to give advice on soil conservation methods, &c., and to provide free planting materials.

The report of the Sub-Committee was considered at the last meeting of the District Agricultural Committee and it was decided to request the Ministry concerned, probably, Agriculture, to see its way to implementing most of the recommendations. It was also decided to send a copy to the Central Board of Agriculture so that they could bring pressure to bear on the Government to implement these proposals and also to get certain oil companies, like the Shell Company, to publish some of the posters and booklets".

Chairman—" The A. G. A.'s observations refer to a valuable document which has been prepared by a Sub-Committee of three gentlemen who understand the problems connected with this subject. I would like to circulate this Report to all members and to continue discussions at a later meeting. Major Fonseka's resolution raises some important issues and there have also been some very useful suggestions made by other speakers. I think we should consider all these suggestions and frame appropriate resolutions to include the D. A. CC. proposals as well ".

This was agreed to.

IV (i)—Resolution by Mudaliyar S. Armstrong

" THAT IN VIEW OF THE LARGE EXTENT OF PADDY LANDS THAT ARE SITUATED BORDERING THE LAGOONS OF THE BATTICALOA DISTRICT BEING SUBMERGED AND DAMAGED BY FLOODS ANNUALLY, SUITABLE OPENINGS OF SAND BARS SHOULD BE EFFECTED DURING THE SOUTH-EAST MONSOON."

Mudaliyar S. Armstrong—" Mr. Chairman and Gentlemen—when I first read resolution No. 1 which has been brought forward by Mr. Wijewardena, I thought I might be censured, so I had to bring out what I should say in points and now I will explain those points. Anybody going towards Batticaloa will find that a large extent of paddy lands around the brim of the lagoons is submerged under flood water during the wet season. Batticaloa lagoon extends along the east coast for a length of 28 miles from Eravur on the north and Kalmunai on the south. It covers an area of 42 sq. miles with a catchment of 1,065 sq. miles. The most important openings of this lagoon are at (*a*) Batticaloa (near the lighthouse), and (b) at Kallar (18th mile). The Batticaloa sand bar when cut open stretches to about 800 feet in width and gets closed between the months of May and November. During the last 15 years (from 1940 to 1955) this mouth has been closed ten times so that when this mouth is closed the mouth at Kallar normally remains closed, and during the period from May to November the lagoon becomes a lake. During this period the water level of the lagoon is about 1 foot above mean sea level at most and begins to go down by evaporation and may go down as low as 9 to 12 inches below mean sea level. Taking advantage of this low level in the lagoon the farmers who possess fields south of the lagoon fringe cultivate the area comprising in width from ½ to 1 mile, occasionally using scoops to rid their lands of water for sowing during September. With the advent of the rains in October-November, the lagoon level rises and the cultivators of the upper region manage to harvest their crops. With the progress of the South-East monsoon rainy season the level of the lagoon rises because the mouth still remains closed and it does not break open by itself once it has got closed. At this stage manual labour has to be employed to cut open the sand bar which would by then be about 200 feet wide from the lagoon water edge to the sea water edge. As a result of this there is often conflict of interest and dispute about the stage at which the sand bar of the mouth should be cut open. Usually the mouth would establish itself if cut before the water level rises to 2.6 inches owing to wave action of the sea. The majority of fields in extent about 8,000 to 10,000 acres which are below 2½ feet get submerged for three to six days until the mouth is cut open and a further two to three days for the saline water to be drained off. On representations made by farmers the Government Agent requests the P. W. D. to cut open the mouth. The farmers also join hands with the P. W. D. Overseer and draw the money for employing labour. This resolution was brought in to eliminate the annual loss incurred partially or totally by those whose lands are bordering the lagoon. My opinion is that since the construction of the dam at Gal Oya more than a third of the water in the catchment area is held up to replenish the Inginiyagala Tank and as a result the flow into the lagoon takes a longer time to rise up to the 2½ feet water level causing the period of submersion of fields longer.

Therefore, gentlemen, my proposals are : (1) To construct masonry groynes to keep the mouth open at Batticaloa Bar, or (2)

for Government to have suitable equipment to cut open the sand bar with some type of hydraulic monitor pumps of high velocity with sufficient force to scour the sand away into the sea to have the mouth opened before considerable damage is done to cultivation. I submit that this work be entrusted to the Gal Oya Board or the Irrigation Department".

Mudaliyar Abulcassim Maraikar seconded the resolution.

Gate Mudaliyar N. Wickremeratne said that he had visualized the outcome of the Gal Oya Scheme long before it was inaugurated. He had visited the area some 25 years ago. He emphatically discouraged Mudaliyar Armstrong's suggestion that that work should be entrusted to the Gal Oya Board. Mudaliyar Wickremeratne was of opinion that the Gal Oya Board was very slow in their work and that no useful purpose would be served by entrusting such work to the Gal Oya Board. He vehemently stressed that the Gal Oya Board should be scrapped and that its functions should be undertaken by Revenue Officers.

Mr. S. A. Selvanayagam—"Mudaliyar Armstrong has merely gone into only one aspect of the question. People of Batticaloa as a whole depend for their fish from the Batticaloa lagoon. The implementation of Mudaliyar Armstrong's proposal would adversely affect the supply of fish from the lagoon. One has to investigate the question whether by keeping the sand bar open for long periods there would be an influx of fish from the sea to the lagoon or the lagoon to the sea. I think we should consider this aspect from the point of view of food production and, therefore, it is a matter that has to be carefully gone into. That is one aspect, the other is whether the opening of the sand bar is going to affect the growth of fish in the Batticaloa lagoon. The fishing industry is a very large one and several hundreds of people live by it. Therefore, when the Board is considering a matter of this nature they will have to be careful as to how they should decide".

Mr. S. Arumugam, Assistant Director of Irrigation—"Mr. Chairman and Gentlemen, it is not the work of the Irrigation Department to keep sand bars open, nevertheless, it is a subject of great interest particularly from an engineering point of view. This particular question of keeping sand bars open in the Batticaloa area is one of great concern and importance. I am glad my friend has brought this up for consideration. It will be interesting to ascertain exactly how this came up. Lagoons and rivers have existed all these days and what is the reason for complaint now? Formerly there was a very good drainage basin in the Batticaloa area. The rains from the North-East monsoon drain into the coastal basins; when a sufficient quantity of water is collected in the basin, heading up higher than the high tide level, the sand bar breaks open as an outlet to the sea. This is what has been happening. Now the basins are not receiving sufficient replenishment—not enough to facilitate the breaking of the sand bar. Hence the inundation.

It is the function of the Revenue Officer to keep the sand bar open. What I would suggest, if I may, is that officers of the Gal Oya Development Board, Engineers of the Irrigation Department and others interested in the subject be called upon by you or some other body to form into a Committee to consider this serious engineering problem".

Mr. C. Wijesinghe—"Mudaliyar Armstrong told us that within 3 days the water level of the lagoon rises and the fields get inundated for 6 days. Could we know the extent of the paddy fields so affected, so that we can have a correct evaluation?"

Mr. S. Arumugam, Assistant Director of Irrigation—"About the fish problem and paddy cultivation and how these will be affected if the sand bar was kept open, I would say that the two interests do not conflict with each whatever. As you know, whenever a source of fresh water enters the sea, the salt-water fish are always at the mouth. On the other hand, if the sand bar existed, the fish in the open sea will not be particularly attracted that way. So that keeping the sand bar open aids cultivation and helps fishing: that is a particular point I wish to add in view of what has been spoken on this aspect earlier".

Mudaliyar Armstrong—"The extent of paddy lands affected is about 10,000-12,000 acres. As regards the second issue of Mr. Selvanayagam, I find from my experience that as soon as the mouth is cut open the

fish not only remain by the mouth but also get into the lagoon. You will find that every time the bar is cut open people who catch fish in the lagoon often catch sharks, about 8-10 ft. in length. Not only that, Sir, fish also got in—sea fish. So that, it is a great advantage for those who enjoy the lagoon fish, which is more liable to leprosy, to have sea fish. As regards the period of flow into the lagoon, I should say that a third or more of the catchment area is held up. After the construction of the Gal Oya dam the water rises gradually. In addition to Gal Oya we are constructing another tank under the Gal Oya".

Chairman—"It would seem that this is a local problem which can be solved by the various authorities concerned. I think the suggestion made by Mr. Arumugam is most helpful—that some authority should summon these various parties to a conference. If I may say so, the best authority to do so is the Government Agent. Being in charge of the District, he would endeavour to solve the problem in the interests of everybody concerned. May I suggest that we write to the Government Agent suggesting that the matter has come to the notice of the Board and that he take it up as suggested ? We may send him a copy of the discussions and ask him to decide on what should be done".

Mudaliyar Armstrong agreed to the proposal of the Chairman.

IV (ii)—Resolution moved by Mudaliyar S. Armstrong

Mudaliyar S. Armstrong—"Before moving the resolution I would like to alter 'earth moving Caterpillar tractors' to read 'earth moving tractors'. The resolution would thus read :

> 'THAT IN VIEW OF THE IMPORTANCE OF LEVELLING PADDY FIELDS IN ORDER TO INCREASE YIELDS, GOVERNMENT SHOULD PURCHASE EARTH MOVING TRACTORS AND SCRAPERS IN ORDER THAT SUCH WORKS MAY BE CARRIED OUT ON A HIRE-BASIS SYSTEM.'

While moving the resolution I must mention about the methods of levelling the fields. Most of our fields in the Eastern Province are not evenly levelled. No doubt we have extensive cultivation, but not intensive cultivation. Apart from that the levelling of fields are such that within a bay in one place there is more than enough water and in other places there is no water at all. As a result it gives a very poor yield on the average. It is for the purpose of increasing the average yield that we want to level the fields, and the C. A. P. & S. Societies are not able to carry out this function because they do not have suitable earth moving tractors. The best thing is for the Department's Engineering Section or any other Department to do the levelling and recover the cost from the owners of the fields. That is my motion. I have once before, in February, 1953, brought the same motion, but I was a bit knocked out by criticism by Mr. Ponnampalam and others. But still I say that it is not the Agricultural Produce and Sales Societies that can carry out this work".

Gate Mudaliyar N. Wickremeratne seconded the resolution.

Chairman—"I think the Director of Food Production will be able to enlighten us on the resolution".

Mr. A. C. Ponnampalam—"Before we proceed we might ask Mudaliyar Armstrong to add : 'Agricultural Produce and Sales Societies'".

Chairman—"I don't think there is anything to prevent the Agricultural Produce and Sales Societies from doing this work, but they may not be in a position to undertake it."

Mr. Ponnampalam—"I don't think Government can do it. We must get the help of the Agricultural Produce and Sales Societies. The sum involved for each person who wants the use of a tractor is a large one. I think most of the cultivators who want their lands levelled are members of C. A. P. & S. Societies, and it is up to them to press the matter through their C. A. P. & S. Societies. Then I am sure the Director of Food Production will have no objection".

Mudaliyar S. Armstrong—"I am glad that Mr. Ponnampalam has made these proposals.

I would like to hear what the Director of Food Production has to say about these matters ".

Mr. N. Manicka Idaikkadar, Director of Food Production—" Mr. Chairman and Gentlemen—you are fully aware of the Government's policy of hiring out tractors to cultivators. At the first stage, the research work is done by the Agricultural Engineer's Branch of the Department of Agriculture, and when the Agricultural Engineer is in a position to recommend a particular research done for extension work, my Department takes it over. We are already doing tractor-ploughing and both Government and C. A. P. & S. Societies as well as Union tractors have been employed.

Regarding heavy tractors for levelling, &c., this has certainly been a long-felt need of the farmer and I am happy that Mudaliyar Armstrong has brought in this resolution. Ever since I came to the Ministry in June, 1952, my Department has been pressing for heavy machines. The former Prime Minister had mentioned to the former Minister of Agriculture and Food that heavy machines are meant for the Ministry of Lands and that the Ministry of Agriculture should confine its activities to light machines. I am not too sure whether this policy is followed now. In any case on the advice of the Agricultural Engineer my Department has asked for a gift of heavy tractors from abroad and if they are received they will be hired out to the people. Perhaps my Department will find it difficult to find the necessary funds from the Food Production Vote for the purchase of the tractors. Hence the request for a gift.

About the point raised by Mr. Ponnampalam, I am very doubtful whether even the best C. A. P. & S. Society or Union is able to handle heavy machines. We have had the unfortunate experience already of certain Societies falling into difficulties with light machines. Perhaps the Batticaloa Union is an exception and they might be able to handle heavy equipment.

If we get heavy machinery we should be able to hire out the tractors in the same way as we hire out tractors for ploughing and harrowing. I think this is a useful motion and it should be supported because this has been a long-felt need of the farmer and I heartily endorse it ".

Chairman—" May I ask Mr. Idaikkadar whether it is a fact that there are types of heavy tractors already loaned by your Department ? "

Mr. Manicka Idaikkadar, Director of Food Production—" There is a great need for this type of tractors and we have borrowed some from the Agricultural Corps and we are doing some work in Anuradhapura and Kilinochchi. The demand is so heavy that we have not been able to satisfy the requirements. But these are borrowed machines, we have to return them soon ".

Mr. C. Wijesinghe—" Right through the discussions it has been emphasized that what is required is heavy machinery like D8. I would like to point out that the U. P. Government of India has placed an order for Rs. 1 million worth of small crawler type tractors, about Rs. 13,000 each, which could do the levelling on the worst types of soil at the rate of 3 acres a day. You can verify my statement and get the necessary information from the Central or Provincial Governments of India. These tractors are manufactured by the Olive Corporation of America, who have enjoyed the monopoly of producing Agricultural machinery even during the war years. Unlike Caterpillar and other firms they have to their credit experience gained during the war years and they are the third largest producers in the world. I think the Government of India has considered all these aspects when ordering these tractors. I myself have seen them working in Hyderabad and I was amazed at their performance ".

Chairman—" I think Mr. Ratnatunga would like to make some observations ".

Mr. D. M. Ratnatunga, Chief Agricultural Engineer—" The Department has about 17 tractors of the crawler type. We are using them on our farms. We haven't enough to go round for hiring. I think the machines are about 60 h.p. About 100 cubes of earth could be moved a day, and the cost is about Rs. 2 per cube ".

Chairman—"Have you heard of the type of tractor mentioned by Mr. Wijesinghe?"

Mr. D. M. Ratnatunga—"Yes. Unless it is 80 or 100 h.p. I don't think it can do the job well".

Mr. C. Wijesinghe—"This is a 23 h.p. kerosene operated".

Mr. Ratnatunga—"We have the same type —John Deere—it moves about 70 cubes a day, costs Rs. 12,000 and runs on kerosene".

Professor Evan A. Hardy—"Mr. Chairman and Gentlemen—In regard to what Mr. Ponnampalam had said I think that we should be able to find equipment within the range of the Co-operative Societies for them to own and operate. I am also inclined to agree with Mr. Ponnampalam's view that particularly in sandy soils the rubber tyred tractors tend to reduce the amount of ware which we get on crawler equipment. In Canada we find quite a number of the larger wheel type of tractors which are able to handle a greater amount of work in a speedier manner. There is some high-speed land-levelling equipment at Gal Oya Valley which I am told had been obtained from Australia. My suggestion is that we should make a suitable study of the equipment that is available. The equipment at Gal Oya may be preferable in newly developed land for high-speed levelling but what is required here is some equipment that could be loaned. My suggestion is try a few John Deeres and see what it is worth. I think we should also make a study of all makes of equipment".

Chairman—"I think from the discussion that has ensued there is no opposition to the motion. May I take it that you approve of the resolution? I will send it on to Government".

V—Resolution moved by Mr. Ray Wijewardena

"THAT THE POSSIBILITY OF A REGULAR WEATHER FORECASTING BROADCAST IN ALL LANGUAGES BE INVESTIGATED AND ALSO THAT IN VIEW OF THE IMPORTANCE OF LONG-RANGE FORECASTING—PARTICULARLY DURING HARVEST TIME —THE POSSIBILITY OF THE APPROPRIATE DEPARTMENT OF GOVERNMENT CORRELATING REPORTS FROM OTHER COUNTRIES INTO REALLY LONG-RANGE FORTNIGHTLY BROADCASTS SHOULD BE INVESTIGATED".

Mr. Wijewardena—"Mr. Chairman, fellow agriculturists—Throughout the centuries, the weather, and particularly rainfall, has been one of the most formidable factors with which the farmer has had to contend. We cannot possibly do without rain, and yet it never comes in moderation; it is either too heavy or too light, too early or too late. No single factor affects this country's agriculture more acutely, and yet no single factor has been more overlooked.

Arable farming, and particularly paddy, in this country is perhaps the most affected of all our agriculture. Harvests are constantly ruined because rains came too late or too heavily or not at all. Hazards such as this are keeping far too many of our young people away from the land, as Agriculture is considered by far the most uncertain of all vocations. And yet this need not be so. Scientists can nowadays at least forecast quite a long way ahead what the weather will be like, even if they are unable as yet to make rainfall any where they wish. A weekly weather forecasting service will be of considerable importance to the farmer as a means of reducing, if not yet eliminating, the major hazard of his profession.

All over the United States and the United Kingdom the Farmers' Weather Forecast is broadcast every morning at a fixed time and is religiously listened to by them all. In this country we are singularly fortunate. We do not have to contend with sudden frosts, or snows, rain being our only hazard in the weather line. A weekly forecast broadcast at a fixed time and on a fixed day will be ample for our needs provided that the necessary information can be obtained, and there is no reason why it cannot.

So far in this country we have only been given forecasts up to one or two days ahead, but with the correlation of results and

atmospheric data from all over the world, and utilizing the fine store of rainfall, temperature and wind statistics which our Meteorological Department has been compiling over the last 75 years, there is now no reason why a long-range forecast is not possible up to even one or two months ahead. In most cases it will be possible to provide a general forecast as to the probable tendencies of the monsoons up to even six months ahead. A guess based on sound scientific principles will be better than no guess at all.

If my resolution is accepted in principle, may I suggest that a committee be elected to go into this subject in detail with the appropriate Departments concerned and place their findings before the next meeting of this Board for adoption or otherwise ".

Mudaliyar Abulcassim Maraikar—" I have great pleasure in supporting this motion. I have had a lot of experience in matters like this. This motion is going to help us a great deal in the direction of food production. Owing to the vagaries of weather conditions we are unable to carry out paddy cultivation successfully. Owing to unseasonal rains, whenever we want rain we are denied it and whenever rain is not wanted we get rain, with the result that successful and methodical cultivation is not possible. Therefore, our food production suffers tremendously. I was delighted to read the motion on the Agenda and I feel that all of us should give our earnest consideration to this motion with a view to solving the problem and to making the authorities concerned conduct scientific investigations on making long-range forecasts of rainfall. This would enable farmers and cultivators to launch out on extensive cultivation and thereby increase the food production in the country. Otherwise uncertain weather conditions cripple farmers because the moment the seed is sown there is excessive rain necessitating re-sowing. Therefore, if this question is to be to some extent tackled and long-range broadcasts of weather conditions are available, we will be in a better position to do our paddy cultivation ".

Chairman—" I have had a letter sent to me by the Parliamentary Secretary to the Minister in charge of Broadcasting, which I shall now read to you :

> 'Reference the resolution regarding 'Long-Range Weather Forecast' I have got the Director of Meteorology to give me a report regarding this resolution. I have enclosed same so that you may enlighten the members of the Board on same. The Broadcasting Department is prepared to put on the air whatever is given by the Meteorological Department. Both these Departments are under my Ministry of which I am the Parliamentary Secretary'.

Now that the Director of Meteorology is here I need not read his letter. I should also say that I have a letter from the Director-General of Broadcasting, who is prepared to put over the air any material which is forwarded by the Director of Meteorology. His letter reads as follows :—

> 'With reference to your letter of the 13th instant regarding the resolution to be moved by Mr. R. Wijewardena at the next meeting of the Central Board of Agriculture, I do not think it will be necessary for me to attend this Meeting in person because my own contribution to the discussion will have to be confined to the broadcasting side. So far as I am concerned, forecasts of the type referred to by the mover can be put over the air if the forecasts are available from the Department of Meteorology. The officer who has to be consulted in this, therefore, is Dr. Dassanayake, Director of Meteorology, who will have to say whether forecasts of that type are possible in Ceylon' ".

Dr. D. T. E. Dassanayake, Director of Meteorology—" I think the letter that I sent the Parliamentary Secretary to the Ministry of Posts and Broadcasting really gives the outline. I quite agree with the mover of the resolution and the seconder that if we could have long-range forecasts it would help the Agriculturist considerably. There is no getting away from that. But anyone listening to the mover of the resolution would think that long-range weather forecasting is a very simple matter, and that only

nobody has so far thought of asking for it. I can assure members that forecasting weather has been attempted for at least a century. Take for instance the British Meteorological Organization, which is a very large one, where, in addition to the Director, there are 4 Deputies and 9 Assistants. Their annual expenditure is about Rs. 40 million. Their position today in regard to weather forecasting is that they can forecast the weather precisely for 12 hours, give a fair outlook for another 12-24 hours, and give a 4-day forecast on an experimental basis, after many years of experiment. Captain Douglas, who was their Senior Forecaster for many years and who retired last year, summed up the position only last year when he said that weather forecasting is very complex and that long-range forecasts will not be a success for a very long time to come.

One would think that with such a large organization and resources, it should be an easy matter. I can assure you it is not. I have been in charge of the Ceylon Meteorological service for 16 years. I had worked for 2 years under Sir David Brant, an authority on Meteorology, but weather forecasting is not easy I assure you. Weather processes take place in three dimensions: length, breadth and depth of the atmosphere, but most of the observations available are ground level. We now plot at the Forecast Centre the weather chart over a large area, from Africa to Japan and China to Australia, but England and America plot the weather chart for the whole of the Northern hemisphere. With all that they still cannot forecast the weather with any degree of confidence. It is no use putting out a forecast on a guess basis. When a Meterological Service puts out a weather forecast, the public will accept it. Unless there is some ground for giving that forecast there is no use guessing it. Anyone can guess.

Seasonal forecasting is another matter. That is giving the forecast of the coming South-West Monsoon for instance. South-West Monsoon Forecasting is a classical attempt at seasonal forecasting. It was first attempted in 1878 after the terrible Indian famine of 1877, when the Director-General of the Indian Meteorological Service was asked to forecast the coming South-West Monsoon.

I have made a careful study of this subject of long-range weather forecasting. There are really several different methods employed. Sir Charles Normand, who was Director-General of the Indian Meteorological Service for many years, as the President of the Royal Meteorological Society, gave his presidential address on the history of the forecasting of the Indian Monsoon. He said: 'there is no harm in attempting it but the people will have to take it with caution'.

I notice that the wording of the resolution is for the matter to be investigated. I am glad that Mr. Wijewardena is not asking me to put out fortnightly forecasts straight away. The matter should be investigated, and to that extent I quite agree. In fact I have been trying to convince the Government that seasonal weather forecasting should be attempted, because there is a great economic value in it. I am not going to promise, however, that it will be a success tomorrow or the next month or next year. One thing I must say is that Ceylon is at a disadvantage in comparison with European countries or America, because here we are a small Island surrounded by the ocean; the weather comes from the ocean and till it hits us we get very little information.

I hope nobody would be optimistic enough to think that for the asking fortnightly weather forecasts could be given."

Chairman—"I take it, therefore, that you are in agreement with the substance of the resolution and that you would like to investigate matters. Actually it will serve your purpose as well as ours if the resolution were accepted and forwarded to Government because you will then be able to get the necessary staff to carry out your work. Gentlemen, we need not then proceed any further. I merely put the resolution up for your approval".

All were in favour of the resolution.

VI (a)—Motion moved by Gate Mudaliyar N. Wickremaratne

Gate Mudaliyar N. Wickremaratne—"I move the following motion to be discussed by the Board :—

"THE SUBJECT OF THE RUBBER REPLANTING SCHEME WITH A VIEW TO ENSURING THE PREVENTION OF SOIL EROSION AND THE POSSIBILITY OF RAISING FOOD CROPS IN RUBBER LAND."

The replanting scheme should have received much more careful consideration before the scheme was launched. From what I have seen and the information I have received, the question of soil erosion has not been fully dealt with. One of the dangers that we have to face with in this country is the question of soil erosion. When the original rubber boom came between 1906 and 1914 a large area of valuable lands, forests and even paddy fields were brought under rubber without any consideration of prevention of soil erosion or other economic issue. These areas of lands in the mid-country and low-country where the population was heavy, were of greater use to the growing population. One of the acute distresses in the country is the setting of paddy fields in the clearing of these forests, another distress is the want of land for growing food crops in these areas. If one goes round the villages where rubber has been planted it would be seen that there is hardly any land left for growing any ordinary food crops such as pulses, fine grains, yams, sweet potatoes or manioc which abounded in those areas before the planting of rubber. Another loss suffered by paddy fields is the loss of fertility of the soil owing to the clearing of these forests. There is yet another loss which is even worse than those enumerated above. At the present time there is a great shortage of dwelling houses all over the country.

The northern part of Matale was really the home for food produce of various kinds. The planting of rubber put a stop to such production.

During the rubber boom many people made money and the rubber produce fetched very high prices, but when the war broke out in 1914 and the price of rubber came down to 10 cents a pound, many suffered heavy losses and ruined their future.

Subsequently there was a food shortage which was unprecedented. The rehabilitation of rubber without consideration of the other economic requirements may be a source of danger to this country. Owing to this rubber we have already got ourselves into a tangle. To dispose of our rubber we were forced to go to the Communists. If communism is bad how could their money be good ? I consider it is worse to eat their rice.

At the present time there is a great shortage of various items of food. Many of these lands can be used for growing crops which would produce such items of food, which would give a return higher than rubber. Mangoes, a fruit which was sold at 2 or 3 cents each, is now being sold at 15 to 20 cents. Oranges, a fruit which was sold at 5 cents each, is now being sold at 30 to 40 cents. Jak fruit which was sold at 25 cents is now being sold at Re. 1.50 each. Bread-fruit which was sold at 5 cents a fruit is now sold at 25 to 30 cents. Even coconuts have gone up in price from 5 cents to 20 cents each. There is thus money in these crops and such crops will relieve the scarcity of food. The planting of cacao and the raising of pepper will also give a better return to the grower, in such areas as Matale.

My suggestion is that regulations should be framed for the better protection of land from soil erosion and also for a suitable extent of land to be set apart for the raising of food crops. The owners of small areas of land, less than, say 2 acres, should be given higher compensation and allowed to grow other crops during a period of 5 to 7 years. I trust that the Ministry responsible for the Rubber Replanting Scheme will consider this matter with a view to fall in line with the life-long work of the first Minister of Agriculture, until we get our self sufficiency".

Chairman—"You are not moving any formal resolution ?"

Gate Mudaliyar Wickremaratne—"I am against resolutions. I am really bringing it to the notice of the members and the appropriate authorities to see that some action is taken".

Chairman—" Mr. Pathmanathan, who is Chairman of the Low-Country Products Association and a member of the Rubber Replanting Board, will make some observations ".

Mr. S. Pathmanathan—" As one who is responsible for framing the regulations under the Rubber Replanting Scheme, I would like to offer a few comments. One of the reasons we are giving the smallholder such a big subsidy is to prevent intercropping. We do not like to encourage food crops on rubber land because first and foremost they affect the rubber trees, the roots of which are very susceptible to disease.

As far as soil conservation is concerned, one of the major objects under this scheme is to see that every holding should have adequate soil conservation measures. Wherever there are lands situated on slopes, it would be necessary to have drains. One of the conditions for the third instalment is that the areas should have drains situated at certain intervals and establish cover for soil protection. These are inspected by the V. A. and on his recommendation we pay the subsidy. We also help the smallholder in lining and pegging contours and send out advisers and inspectors to give every possible assistance. So that as far as soil conservation is concerned, it is one of the corner-stones of our scheme. We would like to see that every inch of the land is protected. In addition, smallholders under the Subsidy Scheme are assisted with fertilizers.

As you are aware, most of the rubber lands are situated on soils containing low fertility and it would be impossible to include food crops which require high fertility.

The Minor Products Sub-Committee has recommended 12 products which should be grown in certain areas. We have suggested that there should be a survey of the Central Province, where rubber is an uneconomic crop, with a view to introducing alternate crops and products like pepper, cardamoms, &c. Very shortly we shall place a report before the Board and also make our recommendations to Government. We have even suggested that a subsidy should be paid to those owners of rubber who wish to have their lands replanted with cacao.

We are very keen on the growing of alternate crops. But before that we would like to make a survey to ascertain suitability of climate, soil and other conditions so as to determine the appropriate crops for particular areas. We have, therefore, asked the Horticultural Officer of the Agricultural Department to collect the necessary information from the various sources so that we could put before you a real plan to help the peasants and others who desire to grow alternate crops ".

Mr. C. A. M. de Silva—" In this instance I support Gate Mudaliyar Wickremaratne. What he seems to want is that certain areas should be set apart for the growing of food crops ".

Gate Mudaliyar N. Wickremaratne—" I am glad that you are reconsidering the matter. I don't want to mix this question with the old food production scheme, which was a senseless one, and the present intercropping, which is another thing. What I want is that certain areas should be set apart for the growing of food crops. It has been said that soil erosion is being tackled by the proper opening up of drains—that is the very thing I want stopped. All the top soil is washed away by drains.

After all these people are not following the programme planned by the late Mr. D. S. Senanayake by replanting rubber. Replanting rubber for what ? To sell our rubber to Communists ! "

Chairman—" I don't think we need worry about the political implications of all this. I think, gentlemen, we know the viewpoint of the Gate Mudaliyar. He is no doubt a great enthusiast for food production. He desires that all those who grow rubber should have a certain portion reserved for food production. This Board is not, I think, competent to make any decisions in regard to the inclusion of rubber within the terms of the Estates Food Production Act ".

Mr. C. Wijesinghe—" That is not the intention of the mover. What he says is that where a subsidy is given a certain percentage of the total acreage that is being replanted should be devoted to food production. The object of the resolution must be that instead

of replanting uneconomic rubber areas, the land should be utilized for the production of food ".

Mr. Pathmanathan—" The Rubber Rehabilitation Board has itself suggested that where there is uneconomic rubber, the land should be made use of for the growing of cacoa in the mid-country ".

Chairman—" I think the object of Gate Mudaliyar Wickremaratne's resolution will be served if instead of replanting rubber in uneconomic areas, other crops such as coconuts, pepper, &c., were planted. I think the Minor Products Sub-Committee has gone into this matter and it would be best to leave it at that for the moment. The first step in any rubber replanting scheme, as Mr. Pathmanathan has pointed out, is to attend to soil conservation. From the discussions today it would appear that these objectives have been borne in mind, and I do not think any purpose will be served by our passing a resolution on the matter. Will that meet with your approval ? "

Gate Mudaliyar Wickremaratne agreed.

VI (b)—Motion by Gate Mudaliyar N. Wickremaratne

" THE ESTABLISHMENT OF MANURE DEPOTS IN VARIOUS PARTS OF THE COUNTRY TO SUPPLY FERTILIZERS TO PADDY CULTIVATORS."

Gate Mudaliyar Wickremaratne—" The fixing of a guaranteed price for paddy by Government has no doubt given an incentive to paddy cultivators to bring their lands under paddy, but a great majority of them own only a few measures of sowing extent and the resulting yield is required for their own consumption. They are also unable to improve the conditions of their paddy fields. Others who are able to sell a part of their produce do not take the trouble to find ways and means of improving paddy fields. Some others who own paddy fields have left the cultivation in the hands of the cultivators. So there is a tendency to neglect the paddy fields and its capacity to yield more. The facilities that existed for the proper cultivation of the land are fast disappearing.

Cultivators who used to collect leaves and twigs of trees to form manure for their paddy fields cannot find them now. Cattle, which used to roam about grazing in paddy fields, used to give a certain amount of fertility to the soil, but now no cattle are available in the villages. Water that percolates through the forest and hills used to bring down some nitrogen to the soil, but the water that comes down from the hills now bring down silt instead of manure. The arrangements that have been made to supply manure at the present time do not meet the needs of the cultivators satisfactorily. Anybody who wants manure must be able to get it at the time of his need as one buys his requirements from a boutique or a shop. The establishment of manure depots in various parts of the country will help the cultivators to return to the soil some part of the fertility of the soil consumed by the paddy crop.

In present times we have heard so much about experts coming to the country to advise us on the improvement of paddy and other crops. Have these experts been able to give us any help ? I think not. One of them, Dr. Koshal, spent a considerable time in surveying our paddy fields to give statistics of their yield. Are these of any use to us ? I do not know what inspiration the officers of the Agricultural Department get from these visitors ".

Mr. N. Manicka Idaikkadar, Director of Food Production—" When the present Ministry was formed the former Permanent Secretary, Mr. Somasuntheram, had in mind the idea of establishing manure depots. The difficulties of storage and the fluctuations in the market price of manure have placed great hindrances in the way of C. A. P. & S. Societies, and quite a number of them have not recovered their losses. What we normally do is to ascertain the exact requirements of a Society and then send it from Colombo. This system is working fairly satisfactorily. Not more than 1,500 tons were issued in 1952. We are now issuing almost 4,000 tons per season. If we have Central Stores it may well mean that somebody will have to foot the bill for the start and the running expenses and also any losses incurred. If, for instance, we are not able to supply enough manure because of the inability of our supply depots

to cope with the orders, then I think it is a matter for consideration. But I think as the issues of manure have risen from 1,500 tons in 1952 to 8,000 tons a year now, it does not seem necessary to embark on any new ventures. Especially from the practical point of view of storage difficulties and fluctuations in market prices, I am not sure whether we should support the motion as it is. I would rather like the motion brought up about 6 months hence to see if there is any further difficulty ".

Gate Mudaliyar Wickremaratne—" It is essential that the cultivators should be able to obtain manure whenever they want. There is no reason to worry about storage, because when a certain amount of manure is required orders could be sent to the Director of Food Production, and the stocks received could be disposed of at once. As stocks are utilized more stocks could be brought in. I think some thing must be done—there must be co-operation. Without manure you cannot increase the yields of paddy. The Department is blamed for not increasing the yields. The experts who come from other countries try to explain how to increase our yields. But it is by the use of good manure in cultivation alone that we can increase our yields. You must return to the soil what you get from it. Good manures in liberal quantities should be available for the cultivators in their localities for them to purchase. This facility should be provided for them by establishing manure depots ".

Mr. M. B. Samarakoon—" In fairness to the Director of Food Production and the Registrar of Co-operative Societies I must say that the distribution of manure through C. A. P. & S. Societies is working very satisfactorily at the moment. The present position is that there are cases of even societies with overdue loans being issued with manure by the Director of Food Production because it is an essential requirement. I am the President of a C. A. P. & S. Society. Recently we assessed our requirements of manure at 350 cwt. and this was issued to us by the D. F. P. Later we found that we required another 300 cwt. and although we had no supplementary provision, this quantity too was issued to us by the D. F. P. I must say in fairness to the Director of Food Production that the consumption of manure has increased ".

Mr. S. C. Fernando, Registrar of Co-operative Societies—" Out of a possible membership of 600,000, there are at present not more than 200,000 members of C. A. P. & S. Societies. I think with an increase in membership this problem of manure distribution could be solved to a great extent ".

Mr. A. C. Ponnampalam—" If non-members are also allowed to buy even at a higher rate it would be very helpful ".

Mr. M. B. Samarakoon—" I must mention that even non-members are issued at the subsidized price. They are only not given loans ".

Chairman—" Is it a fact that manure is issued only to members ? "

Director of Food Production—" The subsidy has to be given through the C. A. P. & S. Societies. I do not think it is restricted to members ; it is given through the societies ".

Mr. Ponnampalam—" It would be helpful if a circular is sent out to all members stating it very clearly that everyone is entitled to purchase manure through the C. A. P. & S. Societies ".

Chairman—" I will commend this to the Director of Food Production and the Registrar of Co-operative Societies.

I, therefore, think that the matter may be taken up in another 6 months time. We could then see how the distribution of manure is working ".

Chairman—" Gentlemen, I would now call upon Dr. Ramiah of the F. A. O. to speak a few words to you ".

Dr. K. Ramiah—" It is very kind of you, Sir, to have given me the opportunity to be present here this afternoon and to listen to the very interesting discussion on various topics. I am concerned more as a Rice Adviser to Asian countries under the Food and Agricultural Organization. I just keep in touch with problems of production as they exist today and how production could be intensified. My chief contacts are the Technical Officers of the Department. Unfortunately I do not come in contact with politicians or others who may be directly or indirectly interested in food production.

This morning I was asked to attend a meeting of the Sub-Committee on Paddy, where the problem of production of pure seed and its supply came up for consideration. There was much work to be done by the technical officers of the Department to effect increases in production. One of them refers to the distribution of good seed to rice growers. Apart from any other measures, like for instance, the use of fertilizers, use of better implements, control of pests and diseases, and so on, and better marketing, and so many other considerations, you can easily pick out that the distribution of good seed to the farmers is a direct and most easily achieved contribution to an increase in production. It is a long-term process but at the same time it does not involve any additional investment. Now, the pureline breeders are engaged in different countries in producing new varieties either by selection or by hybridizing two varieties and thus producing an entirely new one suited to their conditions. Often in many of the countries where this breeding has been in a fairly advanced stage the benefits of such breeding work have not borne fruit. Unless the old indigenous varieties are replaced by improved varieties you would not get the full benefit of your work.

They have very well organized seed breeding programmes in certain parts of India and Burma, but they didn't get much headway for the simple reason that such programmes were not accompanied by properly organized seed multiplication and distribution programmes So the F. A. O. paid special attention to the seed schemes and brought to the notice of Governments concerned that they should pay a little more attention than they are doing at present to this aspect. The problem of maintenance of multiplication schemes for each country to suit its needs has certain requirements, but the essentials of it are that any new varieties must be maintained by the Department of Agriculture in its Experimental Stations. That responsibility must continue to remain.

The next stage is that before the seed is given to the cultivator it must be multiplied—that can be done either on the Government Farms, whether they are large or small, or by arrangement with prominent Co-operative Rice Farmers and multiplying seed on their land. But if it is done on Government Farms it is expected that there will be sufficient technical staff to supervise this work and to purify the varieties before the large-scale seed is made available to the cultivators. This is often ignored and, although it does not cost very much, it is a very necessary and important item of work. The seed at the last stage before it leaves for the farmer must be in a pure condition. Once the seed goes to the farmers themselves, however careful they may be, it is impossible to maintain their purity for a long time. It is usually considered that 3 to 4 years should be the maximum period by which the cultivators should have a chance of renewing their seed supply. After all the expenditure on the maintenance of purity is comparatively very small, and unless you incur that expenditure it very often happens that the full benefits of a breeding programme cannot be realized.

As far as new varieties are concerned, there may be certain types which are not available in Ceylon but well suited to local conditions. For instance, in Ceylon I have found that the imported varieties—one from Indonesia and one from India—are found to be doing very much better than the local varieties. Once you are sure that the variety is acceptable and brings the grower a better yield, the seed scheme must be put into effect as early as possible.

I might thus bring it to your notice that this seed distribution and multiplication programme in a country like Japan rests mostly with Farmers' Associations and Village Co-operatives, and the Central Government subsidized these Associations and Societies to the extent of 10 million dollars last year. The Central Government spends large sums in the way of subsidies to help Co-operative and Villagers' Organizations to multiply and maintain the purity of the seed so that the seed will be available to the rice farmers. This is very useful. No wonder, in Japan the seed programmes go hand-in-hand with production of new varieties with the result that over 70 per cent. of the rice areas is devoted to improved varieties. I think the next country is probably Burma which has 15-20 per cent. In Ceylon too, I think it is about 15 to 20 per cent. Once a new variety is available, all the areas suited for it must be cultivated with this new variety. If this is done there is no other easier method of increasing production.

The improved yields in various countries differ and in some countries it is declared to be 10 to 15 per cent.; this percentage is always sure. The breeder is not worth his job if he does not get at least a 10-15 per cent. increase.

I am thankful to you for this opportunity of being able to address you all. In conclusion I would request you all to co-operate in carrying out good seed programmes so that the benefits of breeding could be passed on to the farmers".

Chairman—"We have one more item on the Agenda—the reports of the Sub-Committees. I understand some of these met this morning. May I suggest that these reports be circulated to all members of the Board for discussion at the beginning of the next meeting ? I think it would perhaps be appropriate because members would then have an opportunity of making any comments they wished".

Agreed.

Chairman—"Mudaliyar Wickremaratne reminds me of the subject of Sugar Cane Cultivation. The matter has not progressed very much more than when it was last discussed. The time is not appropriate now on account of the question of finance. When the time is favourable the matter could be taken up again".

The meeting terminated at 5.30 p.m.

N. P. WIJEYERATNE,
Secretary,
Central Board of Agriculture.

Peradeniya, February 10, 1955.

GOVERNMENT NOTIFICATIONS

THE FOOD PRODUCTION (ESTATES) ACT, No. 40 OF 1954

(Extract from the "Ceylon Government Gazette" No. 10,776 of March 11, 1955)

L. D.—B. 27/54.

REGULATIONS made by the Minister of Agriculture and Food by virtue of the powers vested in him by sections 9 and 20 of the Food Production (Estates) Act, No. 40 of 1954, and approved by the Senate and the House of Representatives.

J. R. JAYEWARDENE,
Minister of Agriculture and Food.

Colombo, March 5, 1955.

Regulations

1. These regulations may be cited as the Food Production (Estates) Regulations, 1954.

2. In these regulations, unless the context otherwise requires—

"Act" means the Food Production (Estates) Act, No. 40 of 1954, and

"rubber estates" means any estate wholly cultivated with rubber.

3. The Board of the Tea Research Institute of Ceylon shall, in respect of every estate held by that Board, be exempt from the whole of the liability imposed by section 4 of the Act.

4. The Coconut Research Board shall, in respect of every estate held by that Board, be exempt from the whole of the liability imposed by section 4 of the Act.

5. The proprietor of every rubber estate shall, in respect of every such estate, be exempt from the whole of the liability imposed by section 4 of the Act.

6. Where any estate is cultivated partly with rubber and partly with any other plant or plants of any description, the proprietor of such estate shall, so far as the total area cultivated with rubber in such estate is concerned, be exempt from the whole of the liability imposed by section 4 of the Act.

7. Sections 7 and 8 of the Act shall not apply in relation—

(i) to any rubber estate, or

(ii) to the total area in any estate which is cultivated with rubber and which is referred to in regulation 6.

EXEMPTION FOR ANIMAL HUSBANDRY (MILK PRODUCTION) UNDER THE NEW FOOD PRODUCTION (ESTATES) ACT, No. 40 OF 1954

THE following Scheme has been approved with effect from January 1, 1955. The exemptions will be based on the number of Milch cows and stud bulls maintained on the estate. The exemptions will be given in accordance with the following scale:—

Type of Cattle	*Acres*
1. For each milch cow of any high milk-yielding breed (e.g., Ayrshire, Friesian, Red Poll or Jersey Cows) and each milch cow of any cross-bred type graded up for high yields in a scientific breeding programme	2
2. For each milch cow of a medium milk-yielding breed (e.g., cross-bred types such as Cape cows and Indian breeds such as Sindhi cows)	1
3. For each milch cow of a low-yielding breed (e.g., unspecified local breeds)	¼
4. For each stud bull approved by the Veterinary Surgeon of the area—	
(a) If it is an imported stud bull	5
(b) If it is a local stud bull	2
5. For female progeny of over one year of age of an approved stud bull	1

In assessing an estate for exemption under the Scheme, cattle maintained on the estate will count for exemption whether the cattle are owned by the estate or by persons permanently resident on the estate. Village cattle temporarily tethered on an estate will not count for exemption.

It is also important to note that only milch cows will count for exemption. Scrub cows which are not milked, and are not capable of yielding any appreciable quantity of milk, but which are maintained purely for manurial purposes will not count for exemption. Buffalo bulls and cows will count for exemption on the same basis as milch cattle.

Conditions for Grant of Exemption

1. In order to qualify for exemption under the Scheme, an estate must maintain a Herd Register and a Register of Cattle.

2. All cattle on the estate should be identified by brand marks or ear tags, particulars of which must be entered in the Registers referred to above.

3. Every estate which maintains a herd of over 50 cows must maintain on the estate a stud bull approved by the Veterinary Surgeon of the area; the estate must maintain one stud bull for every 50 cows. Estates which do not maintain a stud bull because they are unable to obtain one, must get their cows served either by artificial insemination at a Government centre or by a stud bull outside the estate approved by the Veterinary Surgeon of the area.

4. No bull calf over 18 months or a bull other than one that has been approved shall be kept on the estate unless it has been castrated and made unfit for crossing.

Additional Exemptions for Capital Expenditure

In addition to the exemptions mentioned above, estates which incur capital expenditure on the construction of cattle sheds, milk rooms, &c., will be entitled to certain additional exemptions, particulars of which can be obtained on application to the Director of Food Production. Approved type-plans for cattle sheds can also be obtained on application.

EXEMPTIONS FOR ANIMAL HUSBANDRY—(PIGS, GOATS, POULTRY AND SHEEP)

UNDER the Food Production (Estates) Act, No. 40 of 1954, the under-noted Scheme of exemptions under section 8 of the above Act, will come into operation with effect from January 1, 1955.

I—*Classes of Livestock*	*Rate of Exemption*
(*a*) Pigs of imported breed, per animal, irrespective of whether they are boars, sows or piglings	1/5th of an acre
Pigs of local breed, per animal, irrespective of whether they are boars, sows or piglings	1/10th of an acre
(*b*) *Poultry.*—Laying hens per hen (a minimum of 50 birds is necessary for consideration of exemption)	1/100th of an acre
(*c*) *Goats.*—Breeding goats per animal	1/10th of an acre
(*d*) *Sheep.*—For each sheep	1/10th of an acre.

II—*Additional Exemptions for Capital Expenditure incurred on Buildings such as Sties, Poultry Runs, &c.*

In addition to the exemptions listed above, an estate rearing the above classes of livestock will be allowed further extents for capital expenditure incurred on buildings of a permanent nature erected for animal husbandry purposes such as sties, poultry runs, &c. Exemptions for buildings will be granted on the following basis:

(i) 3 per cent. of the total capital expenditure incurred on buildings after January 1, 1955, will be allowed as "annual depreciation" in the year in which the buildings are erected and in each of the 15 years thereafter.

(ii) The estate will be allowed one acre of exemption for every Rs. 80 of annual depreciation on buildings in the case of tea estates and one acre of exemption for every Rs. 160 of annual depreciation in the case of coconut estates.

III. *Conditions for Grant of Exemption*

(*a*) In assessing an estate for exemption under this scheme, the above livestock maintained on an estate will count for exemption provided they are owned by the estate, or if owned by estate employees, the estate incurs an expenditure of at least Rs. 50 for each acre of exemption thus granted. For purposes of exemption, the number of relevant livestock in each class will be the average number in each variety reared on the estate in the period of 12 months preceding that for which exemption is claimed.

(*b*) In the first year of operation of the scheme (i.e., 1955), and even thereafter, exemption will be based on the number of each variety at the time of each inspection, unless records are available to show the average number reared over the previous 12 months.

(*c*) To earn exemption for capital expenditure, estates must maintain buildings to the satisfaction of the Director of Food Production.

L. D.—B. 12/36.

THE PLANT PROTECTION ORDINANCE

(Extract from the "Ceylon Government Gazette" No. 10,758 of January 28, 1955)

Notice

By virtue of the powers vested in me by regulation 12 of the regulations set out in the schedule to the Plant Protection Ordinance (Chapter 307), I do hereby amend with effect from November 1, 1955, the notice prescribing the treatment for the leaf disease of the rubber trees (*Hevea brasiliensis*) caused by the fungus *Oidium heveae* Stein, published in *Gazette Extraordinary* No. 10,448 of September 17, 1952, by the substitution, for paragraph (5) thereof, of the following new paragraph:—

"(5) The sulphur to be used for dusting shall be free-flowing dusting sulphur powder which conforms to the following specifications:—

(*a*) At least ninety-five per centum of the powder must be capable of passing through either a 300-mesh standard sieve of the British Standard Association or a 325-mesh standard sieve of the American Society of Testing Materials;

(*b*) The powder must contain at least ninety per centum of pure sulphur by weight."

A. W. R. Joachim,
Director of Agriculture.

Peradeniya, January 22, 1955.

RUBBER RESEARCH (AMENDMENT) ACT, No. 3 OF 1955

L. D. O. 46/54.

An Act to amend the Rubber Research Ordinance
(*Date of Assent: February 18, 1955*)

Chapter (Vol. VI., page 444).

BE it enacted by the Queen's Most Excellent Majesty, by and with the advice and consent of the Senate and the House of Representatives of Ceylon in this present Parliament assembled, and by the authority of the same, as follows:—

Short Title.

1. This Act may be cited as the Rubber Research (Amendment) Act, No. 3 of 1955.

Amendment of Section 4 of Chapter 302.

2. Section 4 of the Rubber Research Ordinance is hereby amended by the insertion, immediately after sub-section (3) of that section, of the following new sub-section:—

"(3A) The Board may, in such manner as it thinks fit, borrow money and secure the repayment of any money borrowed.".

ANIMAL DISEASES RETURN
October-December, 1954

Province	Disease	Fresh Cases during the Quarter	Total Number to end of 1954				Balance ill at end of Quarter
			Cases	Deaths	Shot	Recoveries	
Western Province (excluding Colombo Municipal area)	Rabies	73	311	—	311	—	—
	Foot-and-mouth	297	1,576	19	—	1,267	290
Northern Province	Anthrax	5	296	296	—	—	—
	Rabies	3	22	—	22	—	—
	Black Quarter	—	117	117	—	—	—
North-Central Province	Foot-and-mouth	—	986	10	—	976	—
	Rabies	6	8	—	8	—	—
	Black Quarter	8	449	449	—	—	—
North-Western Province	Rabies	3	20	—	20	—	—
	Foot-and-mouth	1,419	1,949	257	—	1,553	139
	Mange	25	25	3	—	22	—
Central Province	Rabies	5	54	—	54	—	—
	Piroplasmosis	—	5	—	—	5	—
	Foot-and-mouth	—	95	—	—	95	—
Province of Sabaragamuwa	Rabies	6	16	—	16	—	—
	Foot-and-mouth	29	177	1	—	176	—
	Black Quarter	—	3	3	—	—	—
Province of Uva	Rabies	7	13	—	13	—	—
	Foot-and-mouth	400	412	—	—	412	—
	Black Quarter	—	14	11	—	3	—
Eastern Province	Foot-and-mouth	1,663	10,850	622	19	9,934	275
	Mange	—	171	40	—	131	—
	Rabies	1	3	—	3	—	—
	Black Quarter	—	36	36	—	—	—
Southern Province	Rabies	4	24	—	24	—	—
	Bovine Farcy	—	12	1	—	11	—
	Black Quarter	—	86	86	—	—	—

T. M. Z. MAHAMOOTH,
Deputy Director (Animal Husbandry) and Government Veterinary Surgeon.

Department of Agriculture,
Peradeniya, February 23, 1955.

METEOROLOGICAL REPORT
October-December, 1954

SUMMARY

THE main feature of the weather in October was the formation of a depression, identified to north of Ceylon about the 20th, which resulted in unsettled weather with overcast skies, heavy, widespread rain, strong winds and stormy seas, mainly in the northern and western parts of the Island. The rainfall was moderately heavy during the period 17th to 21st, and local floods were experienced at many low-lying places in these regions. Kelani Ganga touched the minor flood level on the 24th. During the rest of the month, inter-monsoon conditions prevailed, with scattered evening thundershowers which were heavy in places. The rainfall was heaviest in the south-western mid-country and the adjacent hill country, where a number of stations recorded totals over 25 inches. From this region there was a gradual decrease in rainfall, monthly totals elsewhere in the south-west and in the hill country exceeding 10 inches. In the north-western parts and in Jaffna Peninsula too, the rainfall was above 10 inches. Least rain (totals below 5 inches) occurred at a few stations in the eastern and north-eastern low country. Deviation of rainfall from average has been irregular. Excesses, however, predominated, and occurred in the southern half of the Island and in the northern and north-western regions, the greater excess ranging from 10 to 20 inches. Deficits occurred mainly in the eastern and north-eastern parts, but they were not appreciably high. There were also a few slight deficits scattered in the south-western regions.

The North-East monsoon set in about the middle of November, well ahead of time. From about the 13th, moderate rain with north-eastern winds was experienced in the eastern low country and continued till the 23rd, spreading gradually to the interior. During this period afternoon and evening thundershowers were experienced over the rest of the Island. On the 18th rainfall was widespread, and moderately heavy in places. Monsoon rain occurred again from the 26th till the end of the month. During the early part of the month, the weather was mainly dry, except for some scattered thundershowers between the 3rd and 6th. On account of some north-westerly winds, the period from 7th to 12th was unusually dry; practically no rain was experienced, while nights were very cold with minimum temperatures several degrees below average. Dry weather with very cold nights occurred again on the 24th and 25th, the minimum temperature at Nuwara Eliya on the 25th being as much as 17° below average. The rainfall over the Island ranged mainly between 5 and 15 inches, while there were a few stations, scattered in the north-eastern hill country and in Kegalla District, which received more rain. Least rain was experienced in the neighbourhood of Hambantota, where the receipts at a few stations were less than 2 inches. The rainfall was below normal almost throughout the Island, deficits at many stations ranging from 2 to 10 inches. Greater deficits occurred in the Northern Province and at a few stations in the south-western hill-country. There were a few small excesses, scattered in the eastern parts.

Two depressions in the Bay of Bengal influenced the weather over the Island during December. The first, which was more severe, lasted from the 6th to the 12th, causing heavy, widespread rain and strong winds. The rainfall was heaviest on the 7th and 8th, when many stations in the northern half of the Island and on the north-eastern slopes of the hills recorded daily falls over 5 inches. Consequently, floods were experienced in several parts of Ceylon, while landslides caused much damage to house and property in the north-eastern hill country. The second depression, which lasted from 16th to 19th, was of smaller extent, heavy rain resulting therefrom on the 16th being confined to the north-central parts only. Fairly widespread rain was experienced again between the 24th and 26th, on account of a low pressure area. During the last few days weak monsoon weather prevailed, with monsoon rain in the north-eastern parts and evening thundershowers elsewhere. The first of the month was also a day of heavy, widespread rain, many stations in the north-central parts recording falls over 3 inches. The rainfall over the Island ranged mainly between 10 and 20 inches. Larger amounts occurred in the north-eastern hill country, where some stations received over 30 inches including 40.91 inches at St. Martin's (Lower) Estate. Least rain was experienced in the south-eastern low country, along the south-west coast and in Puttalam District, where the monthly totals ranged from 5 to 10 inches only. The rainfall was above normal, except in the south-eastern low country and in the neighbourhood of Batticaloa. At some stations situated in the south-western mid-country, in Kegalla District and in the neighbourhood of Matale, the excesses exceeded 10 inches. The deficits were generally small.

D. T. E. DASSANAYAKE,
Director.

Station	October									November			
	Temperature				Humidity		Rainfall			Temperature			
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)	Total	Offset	No. of Days	Mean Maximum	Offset	Mean Minimum	Offset
Anuradhapura ..	89·6	+0·7	72·1	—1·4	72	95	8·56	—1·16	17	86·1	+0·3	68·9	—2·9
Badulla	81·4	—1·4	65·9	+0·4	74	95	8·76	—0·13	23	78·1	—1·2	64·9	—0·5
Batticaloa.. ..	86·0	—1·0	75·2	—0·1	76	88	7·47	+0·28	15	83·2	—1·0	73·8	—0·4
Colombo	83·9	—1·1	73·7	—1·1	81	93	12·96	—0·75	25	85·1	—0·2	71·8	—1·6
Diyatalawa ..	74·9	—1·4	61·0	+0·4	79	92	10·64	+1·46	22	74·8	+0·6	58·3	—1·6
Galle	82·3	—0·7	74·6	—0·9	82	90	16·82	+4·77	22	83·9	+0·3	73·6	—0·6
Hambantota ..	84·2	—2·0	74·3	—1·0	82	93	10.89	+6·13	17	85·5	+0·1	72·9	—1·1
Jaffna	84·8	—1·0	76·4	—1·2	80	88	13·83	+4·63	18	84·1	0	71·4	—3·4
Kandy	82·0	—3·7	67·9	—0·1	75	90	14·87	+4·33	24	82·5	—0·4	65·5	—2·1
Kankesanturai ..	86·1	—	76·1	—	76	88	13·00	+3·38	15	84·0	—	75·7	—
Kurunegala ..	86·4	—0·9	72·7	—0·5	76	93	14·41	—0·45	22	86·2	—0·8	70·4	—1·5
Mannar	85·9	—1·0	76·5	—0·8	79	88	19·50	+12·92	14	83·8	—0·8	76·6	+1·0
Nuwara Eliya ..	66·1	—1·5	54·0	+2·0	84	88	14·04	+4·28	23	68·3	+0·5	49·1	—2·1
Puttalam	86·9	+0·7	74·6	—1·0	74	90	16·80	+9·37	18	85·8	+0·2	71·7	—1·5
Ratmalana ..	84·4	—	74·5	—	76	88	11·43	—1·77	26	87·0	—	72·8	—
Ratnapura.. ..	87·0	—0·1	72·2	—0·6	80	95	21·34	+3·33	23	89·9	+2·2	70·9	—1·4
Talawakele ..	71·0	—2·3	58·2	+0·5	84	94	12·20	+2·14	25	73·3	0	55·4	—1·8
Trincomalee ..	86·9	—1·1	75·1	—0·5	74	86	5·43	—4·12	20	82·3	—1·3	74·8	0
Maha Illuppallama ..	88·7	—	72·6	—	69	90	9·24	—0·22	20	84·9	—	69·4	—

Station	November (contd.)					December								
	Humidity		Rainfall			Temperature				Humidity		Rainfall		
	Day	Night (from Minimum)	Total	Offset	No. of Days	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)	Total	Offset	No. of days
Anuradhapura ..	76	97	5·14	—5·53	15	83·5	+0·3	71·7	+1·6	86	98	14·78	+7·26	25
Badulla ..	76	94	5·77	—4·48	20	77·5	+0·9	65·5	+1·0	84	97	11·47	+0·24	24
Batticaloa ..	75	90	14·26	+0·40	19	82·9	+1·0	74·6	+1·0	82	90	14·14	—2·85	25
Colombo ..	73	93	4·73	—8·36	13	83·4	—2·2	72·3	—0·1	80	95	13·91	+8·30	21
Diyatalawa ..	80	97	9·00	—1·42	21	73·5	+1·5	60·0	+1·4	82	91	10·87	+2·80	21
Galle ..	76	90	4·81	—7·20	14	82·8	—0·8	73·4	0	82	93	9·05	+1·83	20
Hambantota ..	75	93	3·21	—4·36	11	83·9	—0·7	73·5	+0·4	82	90	3·27	—2·34	16
Jaffna ..	72	98	5·73	—11·54	10	82·0	—0·5	74·5	+1·4	80	88	16·37	+5·98	19
Kandy ..	72	92	7·61	—3·41	16	81·0	—0·8	67·7	+1·3	78	92	15·62	+6·75	23
Kankesanturai ..	76	84	7·30	—2·66	9	81·8	—	74·5	—	86	93	10·11	+0·37	21
Kurunegala ..	72	95	3·44	—8·95	13	84·3	—1·5	70·9	+0·2	79	97	13·72	+6·94	16
Mannar ..	73	79	7·76	—2·43	10	81·9	—0·9	75·7	+0·8	80	86	15·15	+7·36	19
Nuwara Eliya ..	77	87	4·41	—4·78	16	66·4	—1·4	52·5	+3·6	82	88	13·82	+6·01	21
Puttalam ..	74	93	4·46	—5·67	14	83·9	—0·9	72·7	+1·5	82	95	6·66	+1·11	22
Ratmalana ..	67	85	5·47	—6·65	15	84·5	—	73·1	—	74	88	15·54	+8·89	16
Ratnapura ..	72	95	7·55	—7·24	12	87·6	—0·4	71·7	0	78	98	12·80	+3·68	18
Talawakele ..	76	91	3·61	—4·89	13	70·9	—2·7	57·4	+1·4	82	91	8·62	+3·44	21
Trincomalee ..	78	86	9·03	—4·91	14	81·2	+0·1	74·8	0	86	93	22·47	+9·47	26
Maha Illuppallama	74	90	10·75	—	15	82·6	—	71·6	—	80	93	15·94	+7·88	23

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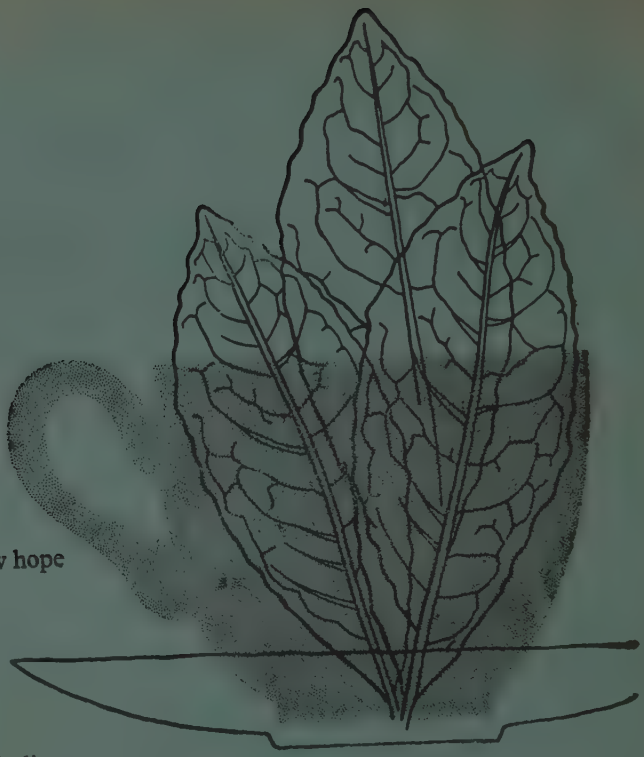
TROPICAL AGRICULTURIST

AGRICULTURAL JOURNAL OF CEYLON

VOLUME CXI
NUMBER 2
APRIL TO JUNE, 1955

DEPARTMENT OF AGRICULTURE
CEYLON



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TROPICAL AGRICULTURIST

Volume CXI **April - June, 1955** **Number 2**

Published Quarterly By

DEPARTMENT OF AGRICULTURE
PERADENIYA, CEYLON

Subscription Rates

(Inclusive of Postage)

	Annual	*Single copy*
Local	Rs. 5·00	1·50
India, Burma and Pakistan	Rs. 6·50	2·00
Abroad	Rs. 8·00	2·50

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Registered as a newspaper in Ceylon.

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EDITORIAL

Minor Agricultural Products of the Island

IN ADDITION to the four major crops of the Island, viz., tea, rubber, coconuts and paddy, a number of economic crops which contribute their quota towards the Island's trade are cultivated in areas suitable for them. Over twenty of these products can be listed, but only the following, which are exported, need be mentioned: cacao, cinnamon, citronella, cardamoms, cloves, pepper, kapok, tobacco, and papain. There are other crops cultivated mainly in home gardens or chenas which do not find a place in the Island's external trade but which have a ready local market and play a part in the development of cottage industries, e.g., sugar cane, cotton, arecanut, coffee, *kitul*, betel, cashew, and fibre plants such as *wetakeiya* (*Pandanus foetidus*), *hewan pan* (*Cyperus dehiscens*), *indi* (*Phoenix zeylanica*), &c. In this review reference will be made primarily to products coming under the former category as they are the most likely to contribute towards the Island's economy.

With the present demands made on the Department of Agriculture for concentrated attention on food crops, but little time has necessarily been devoted by its research staff to the study of the problems relating to these relatively minor agricultural products. Government has, however, realized that this state of affairs must be remedied and has directed that more attention should, in the future, be directed to their study. As a first step a Minor Agricultural Products Sub-Committee of the Board of Agriculture was formed to survey the position in regard to these crops and to determine what steps should be taken in order to rehabilitate the industries which they give rise to. This Committee, with the Horticultural Officer (now Chief Research Officer) of this Department as its Convener, has already set to work and detailed the position in regard to two of these crops, viz., cacao and coffee.

In this connection reference is invited to the useful study carried out by a Governmental inter-departmental Committee on the Citronella industry, extracts from whose report are reproduced in this issue of the *Tropical Agriculturist*. It is apparent that surveys of this nature are of considerable importance as they furnish data which are likely to lead to quick results so far as the rehabilitation of the particular industries are concerned. An example in point is the investigational work carried out by the Industries Department and referred to in the report on the distillation of the oil. By the adoption of a simple modification in technique a marked increase in oil output was obtained. Another example relates to the manuring of the crop in regard to which it was conclusively demonstrated that by the judicious application of fertilizers yields of oil are very appreciably increased and more than compensated for the extra expenditure incurred. These surveys also draw attention to any defects in the trade of particular commodities which may be existent and suggest how they can be rectified. It has been agreed that adulteration, which is widely prevalent in this industry, can be reduced, if not entirely eliminated, and grades of oil well defined by the adoption of a system of certification.

The Sub-Committee in its study of the cacao crop has made a valuable contribution to the development of the industry by recommending to Government that areas suited for cacao and which are now under marginal or sub-marginal rubber should

be replanted with the crop under the Rubber Rehabilitation Subsidy Scheme. The proposal has been accepted by Government and a sum of approximately one million rupees per annum is to be allocated for underplanting rubber lands of elevation 1,200 feet and over in the Kandy, Matale and Badulla districts with cacao. It is proposed to subsidize the inter-planting of cacao in these rubber areas at the rate of Rs. 350 per acre. The Committee has also demonstrated its usefulness in indicating which of the numerous crops referred to should or should not be developed on a plantation scale. In the case of coffee, for example, it has clearly indicated that in view of the inability of Ceylon to compete with foreign coffee-producing countries, the cultivation of this crop for export would be of no advantage. It was, however, the view that coffee should be cultivated as a home garden crop in the villages and that marketing facilities should be improved. The Committee has also recommended that the guaranteed purchase scheme which exists for coffee should be continued and that Government should consider the imposition of an import tariff on the commodity as local production increases. In these various ways the Committee has demonstrated its balanced, sound, and practical outlook, and its further deliberations should be of the greatest value to our research workers, the industry concerned, and to Government.

To pass on to some of the crops themselves. Mention should first be made of the growing economic importance of cacao as a crop both for cultivation on a plantation scale and in peasant holdings. With the impetus given by the high prices prevalent for the commodity since the Korean War—the present average is about Rs. 180 per cwt.—there has been a very marked increase in the extent cultivated with the crop, largely as an inter-crop between rubber. The present extent of cacao in the Island is estimated at about 50,000 acres, but with the subsidized cacao replanting scheme another 25,000 acres would be brought under cultivation during the next ten years. There is reason to believe, however, that the prospect for cacao will remain bright in the near future because of the wide gap between world supply and demand which is not likely to be bridged for quite a long time because of the high incidence of pests and diseases in the major producing areas where most of the plantations are senile owing to failure to replant adequately during the 1934-38 depression. Ceylon cacao which is of the *Trinitario* type has a steady demand because of its fine flavour, and as it constitutes only about 0.4 per cent. of total world production, there is no danger that increasing the extent under cultivation locally by 50 per cent. will upset the supply position and influence prices.

A crop which has been closely connected with the economic life of the people of the Jaffna Peninsula is tobacco, where for several decades chewing tobacco has been grown widely for the Travancore market. With the imposition of restrictions on the import of this commodity by India, there has been a decrease in the production of this variety of tobacco and greater attention is being paid to the cultivation of other crops like onions and chillies. The cultivation of cigarette tobacco is also gradually being extended in the Peninsula but the extent cultivable is limited by soil and other factors. Cigarette tobacco has, however, made considerable headway in other parts of the Island and there are today about 5,000 acres under this crop due to the encouragement given to its cultivation by the Department, the fixing of fair, guaranteed prices, and the provision of facilities by cigarette manufacturing companies. The report of the Commission to inquire into the tobacco industry in the

Island, which has just published its report as Sessional Paper XIV of 1955, is commended for study by those who are in any way connected with the industry. The main recommendation of this Commission is the creation under a Tobacco Industry Act of a Tobacco Board which will control the production, distribution, sale and marketing of tobacco and its products, and be the adviser to Government on matters relating to the industry. With the creation of some such Board there should be a marked advance in the development of the tobacco industry in the Island.

A crop with distinct possibilities is pepper, of which approximately half the total production of about 5,000 tons is exported. Prices rose to a very high level in 1951 owing to a fall in world supplies but have now reached a point when agronomic research is called for in order to ensure production at economic prices. The small grower is, however, protected by the operation of the Agricultural Products Regulation Act. New methods for the vegetative propagation of the crop are proving quite successful.

A review of this nature must take note of cinnamon of which there are about 35,000 acres in the country and of cardamons, of which there are about 6,000 acres. But little investigational work has been done on these products locally and their study would doubtless repay the time and attention paid to them.

Ceylon was the principal producer of papain not very long ago but in recent years production has increased in East Africa and prices have dropped very markedly. Here again adulteration has been responsible for the fall in the quality of the product exported and Government has, therefore, prescribed certain standards of purity which papain for export should conform to before the necessary permits are issued.

No reference to sugar cane need be made here as this has been the subject of an earlier editorial in this journal. It would suffice to state that there is every prospect of a successful cane sugar industry being established in the Island if the project is tackled with adequate preparation and care. Experimental work carried out at the Polonnaruwa Station has shown that high yields of cane of good quality could easily be obtained by adequate cultivation and manuring.

Reference should now be made to a promising dry zone and semi-dry zone crop, viz., kapok for which there is scope for appreciable development in the Island. This crop should respond to good cultivation, and early agronomic investigational work on it is called for. A selection of kapok has been imported from Indonesia and its cultivation is being extended. There is a good export trade in the commodity but care has to be taken that quality standards are maintained. A Committee appointed by Government recommended the adoption of suitable standards but their recommendation has yet to be implemented.

It is clear from this brief survey that there are great possibilities in the development of the minor agricultural products of the Island. With the establishment of a Rice Research Institute in the Department of Agriculture with its own staff, the other research sections of the Department will have the time and opportunity to investigate some of the problems connected with these minor products. There is little doubt that in a comparatively short period results of considerable value should accrue from these investigations and thus appreciably increase the importance of the minor crops in the country and bring greater profits to those engaged in their cultivation.

Agricultural Conditions in the Uva

DUNCAN J. de SOYZA

Geography

The Uva Division, which comprises the whole of the Uva Province, occupies a land area of 3,277 square miles and ranks fourth in size among the nine provinces of Ceylon. On the basis of topography and climate it may be divided into the Upper and Lower Uva regions.

Upper Uva stretches southwards from the borders of Nuwara Eliya along the Hakgala ridge embracing the D. R. O. Divisions of Udukinda, Yatikinda and Wiyaluwa. It comprises the rolling *patanas* and hills of the Uva, the elevation ranging from 2,000-4,500 feet.

Lower Uva stretches from the foot of Horton Plains through the D. R. O. Divisions of Wellawaya, Buttala, Wellassa and Bintenne. The area covers a considerable section of hills, wide undulating plains and vast expanses of flat forest land varying in elevation from 2,000 feet to a few feet above sea level. The hills are largely planted with tea and rubber. The plains of Lower Uva are scattered with varying extents of paddy fed by a net-work of thousands of tanks strung together by a multiplicity of streams and *aras* that ultimately run into the rivers. Here, the natural tree growth is abundant and vast stretches of high jungle (*mukulana*) are found lying contiguous with park land known locally as *damanas* and *talawas*.

Climate

Uva falls within the rain shadow region during the South-West Monsoon; very little rain is therefore received from June to September During the two inter-monsoonal periods and during the North-East Monsoon, Uva receives a fair quota of rainfall, though the distribution is relatively uneven.

In Upper Uva, from October to January, the normal rainfall is characterized by light drizzles of long duration, punctuated often with heavy violent downpours lasting a few minutes. Temperatures are lower in Upper Uva and the air is relatively crisp and dry, which explains the salubrious climate of the dry Uva Uplands. Strong winds of very high velocities are experienced during June and August, so much so that roofs of houses in exposed situations, such as at Palugama, are weighted down firmly against the wind.

In general, Lower Uva receive more rainfall than Upper Uva, the temperatures are higher, and the atmosphere more humid.

Soils

The soils of Uva are mostly lateritic loams derived from ancient crystalline rocks belonging to the Archean or

Precambian Age. They are generally formed from the residual deposits of various basic and intermediate metamorphic and igneous rocks, such as gneisses, quartzites, khondolites and limestone. The pure carbonate limestone is rare, but the magnesium limestone dolomite is found as out-crops running almost east-west in a narrow strip popularly known as the Badulla band. The soils on the whole are deficient in plant nutrients and respond well to treatment. The *patana* soils are yellowish red, fairly heavy loams, very often banded, and sometimes embedded in the matrix are found concretionary material intermixed with undecomposed boulders. Large patches of ferruginous deposits are often seen in bared hillsides.

In the region of dolomitic limestones, the soil is red to chocolate in colour, deep and well drained. In some areas these soils are very near the *terra rossa* type, being almost red. Soils show an acid reaction and are generally deficient in potash.

The soils of the wet *patanas* over 4,500 feet, on the slopes of the Hakgala and Kandapola hills, are characterized by a shallow peat-like horizon of varying depth. This region is constantly moist and imperfectly drained. With good cultivation annual crops particularly temperate vegetables could be grown successfully.

The *patanas* of the dry Uva Uplands may be classed as tropical mountain *savannahs* or *steppes*. They comprise poor, shallow soils with rock outcroppings and are devoid of organic matter. The moisture content is low as these lands are subject to long periods of drought, *patana* fires and erosion by rain and heavy winds. With adequate soil conservation measures and judicious manuring, particularly with organics, good crops could be raised. Fertile patches of good deep soil are however met with in the low-lying areas.

The paddy (gley) soils in the valleys are fairly deep, but badly drained.

The soils of Lower Uva are generally deep, well drained and fertile, but rapidly lose fertility after a few seasons of cultivation unless manured. Regions with deep heavy clays are not uncommon, particularly alongside rivers such as the Telulla area along the Kuda Oya and stretches along the Kumbukkan Oya.

Flora

The *patanas* of both wet and dry Uva Uplands are natural grasslands of coarse, wiry, tufted grasses, such as *Cymbopogon confertiflorus* (*Mana* S), *Chrysopogon zeylanicus* (*Gawara* S), *Themeda tremula* (*Pini-boru-tana* S), *Themeda cymboria* (*Karavata-mana* S), and *Arundinella villosa.*

The forest wealth of Lower Uva is immense, abounding in valuable timber trees such as *Chloroxylon Swietenia* (Satinwood), *Tamarindus indicus* (Tamarind), *Pterocarpus marsupium,* (*Gawalu* S), *Chickrossia tabularis* (*Hulanhik* S), and *Azodirachta indica* (Margosa).

The parkland *damanas* and *talawas* carry a large proportion of xerophytic and deciduous trees, the ground cover

being invariably made up of coarse grasses such as *Cymbopogon confertiflorus*, Mana (S) ; *Chrysopogon aciculatus* (Love grass) ; *Chloris barbata* ; and *Dactyloctenium aegyptiacum*. A pre-dominating fern is the *Gleichenia linearis* (*Kekila* S).

The well known herb gardens of Lower Uva are situated in these parklands. Medicinal trees such as *Terminalia belerica* (*Aralu* S), *Terminalia chebula* (*Bulu* S), and *Phylanthus umbelica* (*Nelli* S) are found in gregarious associations. These trees are annually rented out to the villagers by the Forest Department. The fruits are greatly valued in native medicine.

There are several indigenous fruit trees found in the province. *Rubus lasiocarpus* (Ceylon Raspberry) and *Rubus macrocarpus* (Ceylon Blackberry) are found in Upper Uva. In Lower Uva the following fruit trees are met with : *Elacocarpus serratus* (Ceylon Olive, *Veralu* S), *Dialeum ovoideum* (Velvet tamarind, *Galsiyambala* S), *Psidium guyava* (*Pera* S), *Schleichera oleosa* (Ceylon Oak, *Khon* S), *Dimorphendra Mora* (*Mora* S), *Ziziphus jujuba* (*Masan* S), *Manilkara hexandra* (*Palu* S), and *Hemicyclia acidissima* (Wood apple).

Population and Labour

Of the total population of 4-500,000 about half is agricultural, made up of about 46,500 families. Scarcity of labour is felt in the Lower Uva where villages are thinly populated and cultivable land is readily available. In Upper Uva, though there is sufficient labour, the desire for manual work is fast diminishing and the growing generation is moving to towns and urban areas in search of other employment.

Land Utilization

Though this district has a land area of 2 million acres only about 12.7 per cent. of this is cultivable. The area under actual cultivation is about 8.4 per cent. of the total area or two-thirds of the cultivable extent. Nearly two-thirds of the cultivated area is under permanent crops, such as tea, rubber, citrus and coconuts. The annual cropped area is made up of 34,000 acres paddy, 20,000 acres chenas, and 14,000 acres home gardens and highland cultivation.

Whilst in Upper Uva cultivation in the *maha* season depends on water availability, in Lower Uva it depends on its accessibility and proximity to villages. The hill slopes of Upper Uva, although deficient in organic matter and non-retentive of moisture, can be grown with tea or cultivated with temperate vegetables if proper agricultural practices are resorted to. The lower hill slopes are terraced with paddy fields. Fields at the bottom of these valleys are invariably ill-drained marshes with a water table at ground level.

In Upper Uva, there are about 7,000 acres of such paddy lands optimistically referred to as rain-fed fields. Hill streams tapped for irrigation provide water for nearly 11,000 acres of terraced paddy. However, insufficiency of water makes it impossible to cultivate every year all these fields with the result that some tracts get a sufficient irrigation supply only once every four seasons. Where such irrigation water is found insufficient for paddy work, the available water is used for vegetable

cultivation. Above the level of these paddy fields, but still low down in the valleys are villagers' homesteads and gardens. The water table being high, water is available from shallow wells for domestic needs and for their home garden plots. The gardens contain trees like jak, arecanut, *kitul*, citrus, coffee and one or two temperate fruit trees such as loquat, cherimoyer and pear.

Higher up the slopes in some instances the land is cultivated with such subsidiary crops as cereals, pulses, yams and vegetables during the *maha* season.

The highest slopes or *patanas* are used for grazing cattle. To encourage a palatable new flush in the coarse grasses, the *patanas* are habitually burnt every year during the dry season from June to August. The high winds prevalent during this time of the year carry away the ashes and bits of charred vegetation, depositing them lower down. This vicious circle of burning and close grazing depletes the *patanas* of humus, lowering the useful micro-organic population so essential to support tree life, while simultaneously destroying any tree seedlings that try to establish themselves.

In Lower Uva all arable lands in close proximity to villages are under some form of cultivation. The low-lying lands are paddy fields, while the highlands are either home gardens or *chenas*. Villages are normally situated near tanks.

An important aspect of land use is the long-term policy of the Forest Department in providing wind belts over large extents in the *patanas* and afforestation with valuable timber trees.

The proper conservation of forest as an important factor in influencing the climate and arresting soil erosion is hardly appreciated by the villager and it is not uncommon to find forest and shrub jungle on steep hill slopes burnt down annually for *chena* cultivation.

Crown Land Alienation

Land is alienated to the peasants under the following schemes :—

1. Village expansion—L. D. O. Allotments.
2. Colonization :

   (*a*) Peasant colonization,

   (*b*) Middle Class colonization.

L. D. O. Allotment—Upper Uva

Under the above schemes 14,000 allotments have been given out so far, of which 252 allotments of ½ to 2 acres in extent have been alienated under the L. D. O. Scheme.

The three peasant colonies of Bathmedilla, Okkampitiya and Sorabora-wewa hold 561 allotments covering an area of 3,249 acres, the average size of

a holding being 4 acres paddy land and 2 acres highland. Under the Middle Class Colonization Scheme 43 allotments have been settled over an area of 1,200 acres, the size of a holding being 5 to 25 acres.

The proposed peasant colonization schemes of Yudaganawa, Soraborawewa Right Bank, Maḍakadawewa and Kotiyagala linked with major irrigation schemes presently under construction will cover 1,360 acres paddy and 1,490 acres highland. The middle class schemes of Pelwatte and Bakinigahawela which are under development will absorb 1,050 acres.

Land Ownership

Several kinds of land ownership prevail in Uva and the extent to which land is developed and made use of for any purpose depends on the type of ownership.

The "Gambaraya" System. In this system, which is mostly prevalent in Lower Uva, *Gambarayas* (village caretakers) are appointed by absentee landlords or owners of large tracts of paddy fields to see to the cultivation of these fields by leasing them for cultivation to the villagers. The absentee landlord gets only a small quantity of paddy per acre, the quantity depending on the fertility of the particular tract.

The *Gambarayas* profit the most, as they get a good return in kind for other services such as the loan of seed paddy and buffaloes to cultivators.

Uncertainty of Title. Large extents of land in Lower Uva come under the Waste Land Ordinance. All forest and scrub jungle used by villagers in rotation for *chena* cultivation became the property of the Crown under the Crown Lands (Encroachment) Ordinance of 1840. These lands have since been alienated to capitalists, after the needs of the local village population are met. Until the uncertainty of title to most of this Crown acquired land to which villagers make claim is settled under the land Settlement Ordinance, the development of Lower Uva will be retarded, as the claimants never bother to develop or improve such land or buildings until they are sure of their claims.

The "Ande" System. This system involves the seasonal lease of land to a cultivator on a share basis. In most areas it is on the half-share basis. A few decades ago, when the price of paddy was low and the number of cultivators in relation to cultivable fields was about the same, this practice worked satisfactorily and the exploitation of either party did not arise.

However, during World Wars I and II, when scarcity of rice was felt, resulting in soaring prices, a new system known as *mandaran* was introduced, by which the paddy fields were auctioned, the highest bidder getting the field. With the rapid increase in population during the last decade, the number of paddy cultivators has increased, though the acreage under paddy has not kept pace with the increasing population. The resulting competitive demand for cultivation of fields incited the field owner to dictate his own terms to the prospective lessees. The cultivator on the other hand has no abiding interest in the paddy field as the chances are that he may not get the fields next year. Consequently he does not take the trouble to adopt high standards of cultivation or

effect any permanent improvements to the fields, as he has to share the yield with the owner who offers no assistance. This apathy on the part of the cultivator is reflected on the low yields of paddy throughout the country.

The Service Tenure System. The system that operated in respect of Crown land was abolished soon after the British took over the Kandyan Provinces. The system however continued in respect of private lands, *nindagamas*, and land owned by temples and *devales*, i.e., *viharagam* and *devalagam*. The services due from tenants were specified by an Ordinance passed in 1870. The temple lands are leased out to cultivators by calling for tenders. Invariably some rich person gets the lands and sub-lets them to cultivators. The tenants are expected to perform certain services, failing which the trustee gets the particular work done by some other person and recovers the cost from the tenant. According to the *panguwa* system the lands are divided, and invariably the rich and the influential get the larger portion, paying very small sums as compensation, while the local cultivators have to rest content with small shares.

Tenure of Crown Land. Crown land is alienated to the peasant under the 99-year lease system governed by the Land Development Ordinance. Under this Ordinance fragmentation of holding is not permitted.

Irrigation

Over 21,000 acres of paddy land are irrigated with the help of 23 major schemes which include the Kumbuk Wewa, Handapanagala Wewa and the Balaharuwa tank. Nearly 1,200 acres are irrigated by minor schemes. Under the minor schemes, particularly in the montane zone, the sowing season is inordinately protracted due to the fact that the poor supply of water takes time to reach the lower areas, after being put to full use by the cultivators along the channel higher up the slopes. Owing to this the *maha* sowing season in Upper Uva extends from November to May, the longer duration paddies being sown in higher elevations while shorter duration paddies are sown in the *yayas* below. Several irrigation schemes in Upper Uva have harnessed mountain streams to supply water to vegetable cultivations, particularly in the Udukinda Division where splash irrigation is generally resorted to.

Kumbukkan Oya Anicut—Lower Uva

Paddy

This is the principle crop of the cultivator, occupying about 34,000 acres. Although about two-thirds of the paddy extent is irrigable, owing to the scarcity of water in some areas, several *yayas* are cultivated once in four years and as a result only about 29,000 acres are brought under cultivation in *maha* and about 10,000 acres during the *yala*.

According to the Census Report of 1946 there are about 34,500 holdings of one-acre extent and below, occupying in all about 13,400 acres. Roughly half the total paddy acreage made up of 25,000 holdings is owner cultivated. The other half is held in cultivation under some form of tenancy.

Over fifty local varieties of paddy ranging in age from 3-6 months have been listed as cultivated throughout the province. It is possible that the same variety is known by different names in different areas. Some of the popular varieties are *Pannity, Karayal, Thatuvel, Baduluwi, Rathkunda, Vellai Illankalayan, Murunga, Galkada, Sudu balawi, Pachchaiperumal, Kirikunda, Madarawi, Pusparaga* and *Sulai.* In the Udukinda area the long duration varieties *Pannity* and *Thatuwel* are often sown mixed for the *maha* season, the belief being that *Thatuwel,* though a low yielder, withstands frost and cold winds, and at least one variety will succeed if the weather conditions are not favourable.

Owing to the conservative nature of the villager the replacement of local varieties with departmental purelines is slow. The purelines *Vellai illankalayan* and *Pachchaiperumal* are cultivated over 4,000 acres annually. Recent trials show that the 4½-5 months Indonesian variety *Mas-M24* and the 3½-4 months pureline *Murungakayan* are promising.

The cultivation seasons are very vague and ill-defined. Various stages of paddy cultivation from sowing to harvesting are often seen in the same *yaya.* Paddy is cultivated throughout the year except in September and October, when the cultivator is normally busy in his *chena.* The standard of cultivation is low and the yields are poor in relation to most parts in the Island. Though newly 'asweddumized' lands in peasant colonies have yielded up to 80 bushels or more per acre at the beginning, by the fourth year of cultivation the yields have dropped to 45 bushels. Ultimately these fields will share the same fate as the rest of the old paddy tracts in Uva unless manuring and other improved methods of cultivation are adopted. Apart from the inherent infertile conditions of most paddy fields, the low yields are directly attributable to the slip-shod cultivation methods in vogue. The seed rate varies from 2 bushels per acre in the colonization schemes to 5 bushels in the rainfed fields of Upper Uva. The explanation given by the cultivator for the high seed rate used is that a dense stand prevents lodging and suppresses weeds.

In Upper Uva tillering is poor in low-lying fields, which may be due to the dense stand of plants and unfavourable soil conditions caused by faulty drainage.

Broadcast sowing under wet conditions is generally the practice. Transplanting which was unknown until recent times is gaining ground and about 3,500 acres, about one-tenth the total paddy acreage, are transplanted during the *maha.* The spread of transplanting is limited by the scarcity of labour and poor response to tillering: consequent yields do not compare favourably with broadcast fields.

Where transplanting is impracticable harrowing the standing crop is gaining ground. In the past paddy was rarely weeded, but today about 3,500 acres are hand-weeded to some degree during the *maha* season.

Manuring with organics is new to the Uva cultivator. It is, however, now gaining ground and during the *maha* about 3,000 acres are dressed with organic manures annually. One sixth of the total extent is now dressed with fertilizers. The cultivators obtain fertilizers on credit from the C. A. P. & S. Societies. About 6,000 acres were fertilized during *maha* 1953-54, compared to 840 acres during *maha* 1952-53. This was the culmination of a special fertilizer drive launched during the year 1953.

Improved Methods

The terraced nature of the paddy fields, small size of most of the *liyaddes* and general marshiness of fields in the valleys do not permit the use of tractors in Upper Uva. In Lower Uva where the conditions are more favourable over 1,500 acres were tractor-ploughed during *maha* 1953-54.

The Uva peasant is on the whole apathetic towards the use of proved scientific methods. Improved methods which would produce higher yields offer no lure to the tenant-cultivator as no extra assistance is offered to him and since half the produce plus the seed paddy has to be given over to the owner of the fields. Besides this, the insecurity of tenancy militates against any special effort on the part of the cultivator to effect any permanent improvement to his fields.

However, convincing results obtained through demonstrations in the fields of cultivators by the officers of the Department of Agriculture are gradually weaning the cultivators away from their conservatism and prejudice of the following improved methods :

(*a*) Tractor ploughing.

(*b*) Use of light iron ploughs.

(*c*) Use of ' Burmese Harrow ' in preparatory tillage operations.

(*d*) Use of pureline seed.

(*e*) Green manuring and use of other organics.

(*f*) Use of fertilizers.

(*g*) Weeding.

(*h*) Transplanting.

(*i*) Harrowing the standing crop.

(*j*) Adoption of pest and disease control measures.

Improved Cultivation

Perennial Crops. Among the plantation crops tea occupies an area of 92,225 acres confined to Upper Uva. The extent under rubber is in the neighbourhood of 20,576 acres. In recent times cacao intercropped with rubber is showing promise. There are over 1,480 acres under coconuts mostly grown in home gardens in Lower Uva. The wide range in elevation, climate and soil permits the cultivation of several temperate and tropical fruits ; but except for a few varieties grown round homesteads, the only fruit grown extensively is the citrus of which the Bibile Seedless Sweet Orange is well known.

Citrus is the main perennial crop of the villager and is largely confined to the more or less triangular area stretching between Bibile in the north, Buttala in the west, and Dambagolla in the east, where the famous Bibile oranges and Moneragala limes are

found. Though these crops have been very methodically planted out, continued neglect and uncontrolled diseases have caused premature ageing of trees. In some gardens neglect is so pronounced that jungle has started encroaching on the once lucrative orchards. Unless a replanting campaign is started immediately with proper crop sanitation and attention to the existing younger trees, the citrus industry will be wiped out in the not distant future.

With the decadence of the citrus industry in the Bibile area the prospects of growing pineapple in Lower Uva are heartening.

Estimated Acreage under Citrus in Uva

Orange	..	3,000 acres
Lime	..	800 „
Mandarin	...	400 „
Grape fruit	..	50 „
Total	..	4,250 acres

The extent under plantains is about 2,000 acres, mostly grown as a home garden crop. Over fifteen varieties are found. In the hill country the varieties Chinese Plantain, the *Anamalu,* and *Marthamana* are commonly grown; while in the plains *Kolikuttu, Puvalu,* Ash plantain, *Suwandal, Mondan,* and *Ebmul Hondarualu* are cultivated.

Moringa oleifera, the drumstick, though not normally considered a cultivated crop, brings a considerable annual income to villagers in the Bintenne and Wellassa D. R. O's Divisions; a tree yielding on an average 500 fruits valued at Rs. 5. Other perennial crops normally found in home gardens are: jak, arecanut, bread-fruit, *kitul* and a few temperate fruit trees such as the pear, avocado, peach, cherimoyer, hill guava and loquat.

Annual Crops. Though rice is the staple diet of the villager, his subsidiary food and money crops are raised seasonally both in the *chenas* and in the home gardens.

Chena cropping which is mostly carried out in Lower Uva involves low intensity cultivation, as opposed to garden cultivation in Upper Uva which requires a high degree of intensive work.

There are over 35,000 acres of *chena* in the Uva, of which about 26,000 acres are in Lower Uva. Each cultivator cultivates about five acres of *chena.* The cropping is mostly confined to the *maha* season.

Any type of land varying from high jungle to shrub land, steep hill sides not excepted, depending on the availability of land is cleared and burnt during the dry spell in June-August and sowing is done either by broadcasting or dibbling with the first showers in September-October.

As mixed cropping is the rule, it is difficult to give a fair estimate of the acreage under any particular crop. The main crops of a *chena* are maize, kurakkan, hill paddy, green gram, sorghum, horse-gram, chillies, mustard, gingelly, cotton, manioc and sweet potatoes.

About 600 acres of cotton are cultivated in the Wellawaya and Buttala D. R. O's Divisions, the seed being supplied by the Spinning and Weaving Mills, Wellawatte, who buy the seed cotton. On an average an income of Rs. 150 is obtained from one acre of cotton.

The land close to the homesteads is grown with vegetables such as: *bandakka*, brinjal, tomato, pumpkin and other gourds. The harvest of these perishable commodities from the *chenas* produce a glut in the local fairs, accompanied by a fall in prices during the months of December-February.

In the Udukinda Division the cultivation of temperate vegetables in terraced hill slopes is a specialty and is comparable to the market gardens and truck cropping farms of the more advanced countries. The standard of cultivation is very high and nearly everyone uses fertilizers. Owing to the scarcity and difficulty of transport, bulky organic manures are mostly restricted to home gardens. The average land area cultivated by a family is about quarter of an acre, where single crops or a variety are handled.

Terraced Vegetable Gardens—Upper Uva

Livestock

The total number of milk animals are enough for the normal economy of the people of this province. The problem, however, is that a few people own all the cattle, the result in most cases being the utter neglect of the animals. In many parts of Lower Uva the buffaloes are left to fend for themselves after the cultivation season is over and they roam about in the neighbouring jungles until they are rounded up again in the following season. Neat cattle are used for draught but roaming herds are found everywhere and are a constant nuisance as they damage gardens and stray on to public highways.

Stall-feeding is rare and promiscuous breeding is rampant, little use being made of stud animals provided by the Department of Agriculture at various centres. A good percentage of the cows are not milked as it is sanctimoniously felt that the milk rightly belongs to the calf. The condition of the animals are so poor during the long periods of drought that there is hardly any milk for the calves. Generally speaking about 25 per cent. of the cows are in milk, the average daily milk production being in the order of one to two bottles.

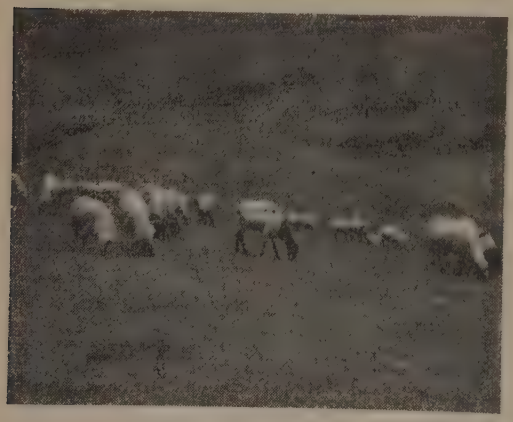
The Sinhala breed predominates in the villages; cross-breeds are found in urban areas. In Upper Uva both in the towns and in estates good European breeds and their crosses are popular. These animals are well looked after and dairying seems to be a sound business, the milk being sold in the towns. Large herds, mostly the local type and cross-breeds are maintained in Upper Uva

tea estates on the scanty grazing found on the *patanas* for the purpose of obtaining manure for composting.

Cattle grazing on *patanas*

The absence of good pasture is keenly felt. Exploratory trials carried out at a couple of centres have proved that *Brachiaria brizantha* does extremely well ; it survives the drought while the *patana* grasses die out temporarily.

The prospects of sheep-farming for slaughter on the dry Uva uplands offers promise. A start has already been made by a private concern and the Department of Agriculture, and from the promising results obtained so far one could confidently recommend this activity in Upper Uva.



Sheep-farming on *patanas*

Pig-farming as a side line in the tea estates in Upper Uva is fast becoming popular, the dung forming a valuable ingredient in compost-making. The animals are slaughtered periodically for pork, a small quantity being cured into home-made bacon. With systematic management the prospects for bacon and ham manufacture are good.

Although goats are found in variable herds in Lower Uva and in small numbers on tea estates, little heed is being taken to improve the stock, although stud animals are provided by the department at various centres.

The poultry in the province is not in proportion per capita of population. Mixed breeds are the rule. However, of late, the R. I. R., White Leghorn and Austrolorp breeds are finding their way to the villages from the agricultural stations which provide hatching eggs and cockerels at concession rates to *bona fide* villagers. In the urban areas there is evidence of better poultry management.

Pests and Diseases

Several common crop pests and diseases are readily controlled by the use of chemical insecticides and fungicides made available to villagers through the C. A. P. & S. Societies. The following, however, become problematical at times : Blast and Swarming Caterpillar of Paddy, Fruit Fly, Fruit Piercing

Moth, Powdry Mildew, Pink Disease, Physiological and Virus Diseases of Citrus and Bunchy Top of Plantain.

Among poultry, Raniket disease becomes fairly serious during certain seasons, while Pullorum and intestinal worms show up at times. As regards cattle diseases, sporadic outbreaks of Foot-and-mouth and Black Quarter occur in the remote areas of Bintenne Korale, these diseases being more or less endemic to the area and sometimes contracted through *tavalan* or pack animals that cross over from the Eastern Province.

Marketing

Vehicular traffic is restricted to the trunk roads, hence agricultural produce is transported to the markets and towns by pack animals.

Private dealers and the Marketing Department purchase vegetables and fruits directly in the villages of the Lower Uva. Of 29 C. A. P. & S. Societies that buy agricultural produce, twenty-six deal chiefly in paddy, one in vegetables, and two in oranges. The guaranteed price scheme has helped the majority of cultivators to market their produce, specially paddy, at fair prices.

Government Assistance to the Farmer

The field staff of the Department of Agriculture instruct the cultivators in proper agricultural practices.

Apart from demonstrations of improved practices in agricultural stations, demonstration plots have been opened up in cultivators' fields to convince them of the advantages of good agricultural practice. These plots have given striking results.

Further assistance is readily offered in the form of seed and livestock propagation material, free stud service, castration of scrub animals, and the immunization of poultry against disease ; but the response of the villager on the whole is far from satisfactory.

Some Aspects of the Chemistry of Rice Soils

F. N. PONNAMPERUMA

Received 26. 6. 55.

THE CHEMISTRY of flooded rice soils is a subject of unusual scientific interest and great practical importance. Its scientific interest derives from the many unusual features of flooded soils. Its practical importance needs no emphasis because rice, perhaps the most important crop in the world, is almost universally grown on flooded soil.

Although rice is almost everywhere grown on submerged land no systematic attempt has been made to understand the behaviour of the rice plant in terms of its peculiar chemical environment. An analysis of the chemical regime in a flooded soil in the context of the rice plant is therefore desirable.

The chemical regime in a flooded rice soil is radically different from that in a normal upland soil and is characterized by :

(i) a deficiency of oxygen,

(ii) an excess of carbon dioxide,

(iii) the presence of large amounts of reduced iron and manganese,

(iv) the absence of nitrates,

(v) the presence of sulphides,

(vi) the anaerobic decomposition of organic matter,

(vii) an increase in the solubility of phosphate and silica,

(viii) an increase in *p*H,

(ix) a decrease in redox potential,

(x) an increase in electrical conductivity.

Deficiency of Oxygen. When a soil is flooded the normal gas exchange that takes place between soil and air is drastically curtailed. Oxygen can enter the soil and soil gases escape into the atmosphere only by a process of molecular diffusion through water. Since this process is about 10,000 times slower than diffusion in air the entry of oxygen into the soil and the escape of soil gases such as carbon dioxide is severely restricted. The net result is that the concentration of oxygen in a flooded soil is reduced to a very low value while that of carbon dioxide and other soil gases is increased. The depletion of oxygen and the accumulation of carbon dioxide have important chemical and biochemical consequences which will be taken up in due course.

The drastic restriction of the diffusion of oxygen does not imply that the entire profile of a submerged soil is uniformly devoid of oxygen : the concentration of oxygen can be relatively high at the surface (34, 36) and perhaps again at some depth in the soil. The surface layer, usually a few millimetres to a centimetre in thickness, in which the oxygen concentration is relatively high, is characterized by its brown colour and the presence of typical oxidized radicals such as ferric iron, nitrate, and sulphate. Also microbiological processes in this layer are much the same as in a well-aerated soil. The direct evidence for the presence of a high oxygen concentration at any depth in a submerged soil is meagre but the accumulation of ferric oxide and manganese dioxide concre-

tions below the plough sole of old rice soils (27, 32, 43) and the high redox potential in this zone (12) suggest that oxidizing conditions prevail. Sandwiched between these two oxidized layers is a zone which may be practically devoid of oxygen. Rice roots are thus subjected to an environment very low in oxygen.

Rice roots, like all other roots, require oxygen for respiration, growth, and accumulation of nutrients. How then do rice roots thrive in a medium so low in oxygen ?

Harrison and Aiyer (18) suggested that rice roots derived their oxygen from the oxygenated surface water that drained past the roots. The beneficial effect of a moderate amount of drainage, on the rice plant, they attributed to improved aeration of the roots. They even ascribed the benefits of green manuring to increased oxygen supply to the roots. Green manuring produced methane which according to Harrison and Aiyer favoured the development of the algal film at the surface, which in turn enriched the surface water with oxygen.

It is unnecessary to go into the patent inconsistencies of this theory. Suffice it if it is said that there is very clear evidence now that rice roots do not depend on their immediate environment for their oxygen supply.

Sethi (42) showed that mature rice roots contained large air spaces. Juliano and Aldama (23) reported the presence of small rhombohedral air spaces even in young rice roots. But it was left to Van Raalte (39) to demonstrate the continuity of these air spaces with the air channels in the shoot system and to provide convincing proof of the transport of oxygen from the aerial parts to the roots. Subsequent work by Vlamis and Davis (51) in America and Mitsui (32) and others (28, 52) in Japan have confirmed this observation.

Not only do rice roots receive sufficient oxygen from the aerial parts for their metabolic needs, but they are also able to exude oxygen into soil and maintain an oxidized environment. Around young roots which actively secrete oxygen (32) a deposit of ferric hydroxide is formed in the soil. As the roots grow older and get suberized the flow of oxygen into the soil gets restricted. Deposition of ferric hydroxide then occurs on the root surface, giving the older roots their reddish brown colour.

Excess Carbon Dioxide. The carbon dioxide concentration in a flooded rice soil can assume a relatively high proportion, especially if fresh organic matter is present. Concentrations as high as 20 per cent. have been reported by Harrison and Aiyer (19) in Indian rice soils. A high concentration of carbon dioxide, even in the presence of an adequate concentration of oxygen, is injurious to plants. It seriously reduces water and nutrient uptake and can be lethal to plants. According to Chang and Loomis (9) a concentration of 15-20 per cent. carbon dioxide in the root zone may kill some plants. Vlamis and Davis (51) found that bubbling carbon dioxide through culture solutions in which rice, barley and tomato were grown was 'immediately lethal' to all plants.

Fortunately, the carbon dioxide concentration of rice soils is below this lethal level, largely on account of the diluting effect of methane invariably present in rice soils. The possibility, however, cannot be excluded of toxic concentrations of carbon dioxide during

the initial stages of the decomposition of organic matter. The failure of rice seedlings on newly green-manured fields may be due partly to carbon dioxide toxicity.

Presence of Ferrous Iron. The reduction of iron is the most striking chemical change that takes place on flooding a soil. The reddish or yellowish brown colour of the soil changes to blackish shades and large amounts of iron are brought into solution.

The reduction of iron is almost entirely the result of the anaerobic decomposition of organic matter. Aside from lowering the redox potential, the anaerobic decomposition of organic matter generates a variety of organic compounds which can not only reduce ferric iron but also combine with the ferrous iron formed to give fairly stable soluble complexes. Two factors that influence the amount of iron reduced in a flooded soil are the content of organic matter and the duration of submergence. This is shown in Table I.

TABLE I

Treatment	*Fe^{+2} (lb./acre) on days from start*			
	0	*8*	*23*	*76*
Well drained	20	32	18	19
Submerged	19	54	3090	6120
Submerged (+0·5% straw)	18	809	4160	7160

Although large amounts of iron are reduced in flooded soils only a very small proportion is present in the soil solution (37). The concentration of ferrous iron in the soil solution is governed by the pH of the soil, the carbon dioxide concentration, the amount of decomposable organic matter and the drainage conditions. A low *p*H, a high content of organic matter, and the absence of drainage favour the accumulation of ferrous iron in extremely high concentrations. This is brought out in Table II.

TABLE II

*p*H	straw %	*Treatment*	*Fe^{+2} in p. p. m. in soil solution after 64 days*
4·9	0·0	well drained	0·1
4·9	0·0	submerged, with drainage	155
4·9	0·0	submerged, no drainage	354
4·9	0·2	submerged, no drainage	435
6·0	0·0	submerged, no drainage	80
6·0	0·2	submerged, no drainage	148

The reduction of iron appears to be one of the important benefits of flooding the soils in rice culture for there is abundant evidence that the iron requirement of rice is higher than that of other cereals (5, 15, 17, 50). There are indications (37) also that the need for extra iron coincides with the step up in metabolic rate associated with the initiation of the reproductive phase.

While a slight increase in the solubility of iron in the soil appears to be beneficial to rice there are strong indications that an excess may be harmful. A widespread physiological disease of lowland rice known as 'mentek' in Java, 'penyakit merah' in Malaya, and browning or bronzing disease in Ceylon may be a manifestation of the toxic effect of reduced products, especially iron. Symptoms strongly suggestive of this disease were observed in a greenhouse experiment and found to be associated with very high concentrations of

ferrous iron (38). Some of these observations are summarized in Table III.

TABLE III

Symptoms	*Ferrous iron (p.p.m.) in soil solution on days from flooding and transplanting*		
	16	*31*	*64*
None	3·2	20·5	80·0
Mild	35·8	81·6	354
Moderate	88·3	207	435
Severe	146	275	525

The build up of high concentrations of iron can be prevented by providing subsoil drainage and minimizing the addition of organic matter, as already indicated. Other practical methods are delaying submergence after transplanting, the addition of sodium nitrate to retard the reduction process, and, simplest of all, liming the soil (37). The effect of the last three treatments on a soil with an initial pH of 4.9 is shown in Table IV.

TABLE IV

Treatment	*Ferrous iron in p.p.m. in soil solution on days from start*		
	1	*28*	*50*
Submerged continuously	1·3	80·0	328
Submerged continuously $NaNO_3$ added	0·8	6·4	78·5
Submerged after 30 days from start of exp.	—	—	82·0
Three tons per acre $CaCO_3$ added and submerged continuously	0·5	48·0	69·5

It is clear from Table II that the accumulation of ferrous iron in the soil solution is highest when a low pH soil with no drainage is submerged for some weeks. It is interesting to note in this connection that bronzing disease of rice in Ceylon is almost exclusively confined to the ill drained, acid soils of the low country wet zone.

Presence of Reduced Manganese. Simultaneously with the reduction of iron or slightly preceding it, occurs the reduction of manganese. Under anaerobic conditions this proceeds so readily that it is only the low content of manganese in soils that prevents a submerged soil from being deluged with soluble manganese.

There is no evidence that the manganese requirement of rice is unusually higher but there are reports that an excess may be harmful (25, 26). There are instances also of manganese deficiency (43). On account of the ease with which it is reduced and rendered soluble, manganese is readily removed from the furrow slice and deposited at lower depths. In sandy soils with drainage manganese deficiency may therefore be expected.

Presence of Sulphides. Like other oxygen-rich substances, sulphate undergoes reduction under anaerobic conditions. The chief end product is hydrogen sulphide. This is also produced during the anaerobic decomposition of proteins, along with other evil-smelling substances.

Hydrogen sulphide even at a concentration as low as 0.1 p.p.m. is toxic to rice. It is fortunate indeed that so long as ferrous iron is present this toxic level is never reached for hydrogen sulphide is removed from solutions as the innocuous ferrous sulphide. But in soils low in active iron such as very sandy soils long under rice cultivation, hydrogen sulphide toxicity might be a serious problem. 'Akiochi' disease of rice in Japan has been attributed to hydrogen sulphide toxicity. The incidence of the disease has increased with

the use of ammonium sulphate as fertilizer (32). Among the remedial measures are draining the fields and adding red upland soil. The use of lime on these soils is avoided because a high *p*H favours the reduction of sulphate.

Absence of Nitrates. Nitrate, in common with sulphate and the oxides of iron and manganese, gives up its oxygen under anaerobic conditions and is reduced to nitrogen. This is known as denitrification. Denitrification is favoured by a *p*H near neutrality and the presence of organic matter.

An intermediate product of denitrification is nitrite. Nitrite, however, has only a transitory existence in rice soils and concentrations in excess of 3 p.p.m. have not been encountered in rice soils (11, 21, 24, 40, 47). This is true even of soils with a high initial nitrate content (37). There is no evidence that nitrite at this low level is toxic to rice. In this connection it may be noted that plants can assimilate nitrite without ill effects from solutions containing as much as 50 p.p.m. nitrogen as nitrite (8).

The use of nitrates as fertilizers for rice has been discouraged on the grounds that nitrates are (i) lost by leaching (ii) converted to toxic nitrite (iii) lost by denitrification (iv) not utilized by rice. Losses due to leaching and denitrification may be considerable but nitrite toxicity or the unavailability of nitrate to rice are not supported by facts. There is clear evidence (5, 17, 29) that rice can utilize nitrate provided the presence of nitrate does not render iron unavailable. In acid soils rich in iron, nitrate may even be beneficial because it retards the reduction of iron.

Anaerobic Decomposition of Organic Matter. The decomposition of organic matter in a flooded rice soil differs from that in a well drained soil in two aspects: (i) it is slower; (ii) the end products are different.

In a well-drained soil, decomposition of organic matter is accomplished by a variety of micro-organisms of which fungi are the most active. Owing to the high energy release associated with the aerobic respiration of these organisms, decomposition of substrate and synthesis of cell substance proceeds at a rapid rate. This results in a rapid release of nitrogen with nitrate as end product if the C : N ratio is less than 16 and the immobilization of nitrogen in the decomposition of highly carbonaceous materials like straw.

In rice soils, on the other hand, decomposition of organic matter, except in the thin surface-oxidized layer, is almost entirely the work of anaerobic bacteria. Since these function at a much lower energy level and are more sensitive to *p*H, the decomposition is sluggish and *p*H sensitive. Also, owing to their lower synthetic activity, assimilation of nitrogen is slow. Thus materials with high C : N ratios may be applied to rice soils without risk of immobilizing soil nitrogen. The findings of Acharya (1, 2, 3) and Sircar *et alia* (44,45) confirm these theoretical conclusions.

Although the C : N ratio is relatively unimportant from the point of view of nitrogen immobilization it does have a marked influence on the rate of release of ammonia as the figures of Joachim and Kandiah (22) and of Mitsui (32) indicate. In some of Mitsui's experiments peak ammonification was

reached two weeks after incubation in flooded soil for all materials with a C:N ratio less than 9.1; as the C: N ratio increased peak ammonification was delayed. The beneficial effect of lime on ammonification to which Japanese workers (32) have drawn attention may be attributed partly to the stimulation of anaerobic bacteria by a pH near neutrality.

The most striking difference between the aerobic and anaerobic decomposition of organic matter lies in the nature of the end products. In a normal well drained soil the end products are carbon dioxide, nitrate, sulphate and resistant residues. The products of organic matter decomposition in a submerged soil are chiefly carbon dioxide, methane, hydrogen, and organic acids derived chiefly from the carbohydrates; ammonia, amines, mercaptans and hydrogen sulphide from proteins; and resistant residues.

The anaerobic decomposition of organic matter may affect the rice plant through (i) the products of decomposition and (ii) its influence on chemical equilibria in the soil.

Of the products of decomposition, ammonia is the most important, for nitrogen holds the key to productivity in rice as it does with other cereal crops. The chief merit of organic matter as the source of nitrogen for rice is that the nitrogen is slowly released as ammonia. Heavy applications of ammoniacal fertilizers, on the other hand, lead to losses (i) by leaching in spite of ammonium being a cation, (ii) by denitrification following the formation of nitrate in the surface layer. They have the added disadvantage that in sandy soils with impeded drainage a heavy dressing of an ammonium fertilizer may cause ammonium toxicity (7, 14, 30).

Among the other products of the anaerobic decomposition of organic matter, butyric acid and methane require comment.

Butyric acid is present in appreciable amounts in the early stages of the anaerobic decomposition of organic matter, may persist in acid soils, and is toxic to plants. The common failure of rice seedlings on newly green-manured fields may be ascribed to the toxic effect of butyric acid and carbon dioxide.

The presence of methane in rice soils appear to be beneficial to rice. Aside from its stimulation of the algal film at the surface and the lowering of the carbon dioxide concentration by dilution, methane, according to Vlamis and Davis (51) produced a marked improvement in the root growth of rice. This interesting observation merits further investigation.

The decomposition of organic matter in a rice soil has undesirable secondary effects: (i) it leads to a rapid loss of nitrate; (ii) it intensifies the reduction of iron, magnanese and sulphate and (iii) it generates carbon dioxide and organic acids which increase the solubility of iron and maganese. Organic manures should therefore be used with caution on acid rice soils with impeded drainage.

Increase in Solubility of Phosphate. When a soil is submerged the availability of phosphate whether judged by plant response or chemical tests increases.

Several investigators (4, 6, 32) had reported that rice grown under flooded conditions did not respond to phosphatic fertilizers although crops grown under well-drained conditions on the same soils did show marked responses. Aoki (4) was the first to suggest that this was due to increased availability of phosphate under flooded conditions brought about by the conversion of insoluble ferric phosphates to soluble ferrous phosphate.

There is very clear chemical evidence that the solubility of phosphate in water and in acid solvents increases when a soil is kept submerged (31, 33, 53). The increase is due principally to the reduction of ferric phosphate. Among the other reasons are (i) hydration of ferric and aluminium phosphates, (ii) hydrolysis of ferric and aluminium phosphates and (iii) solvent action of organic acids and carbon dioxide on soil phosphates.

Conclusion of practical interests are: (i) phosphate may be leached and lost from the furrow slice in rice soils with drainage; (ii) soluble phosphates may be used on acid soils without fear of phosphate fixation and (iii) differences among phosphatic fertilizers will be less marked with lowland rice than with upland crops.

Increase in Availability of Silica. Submergence of a soil brings about an increase in the availability of silica (46, 48, 49). Mortimer's (33) figures show that the increase is associated with the reduction of the soil.

Silicon is not generally recognized as an essential element and direct beneficial effects of slica on upland crop plants are discounted (41). But in the case of the rice plant there is evidence that increased absorption of silica is beneficial.

Solution culture studies by Japanese workers (20, 35) have shown that silicic acid causes an increase in growth and in yield of straw and grain and that it counteracts the harmful effects of excess nitrogen. They have also drawn attention to the beneficial role of silica in increasing resistance to fungal infections (49, 54).

Increase in pH. When a soil is submerged its *p*H value increases. The magnitude of the rise in *p*H depends on the initial *p*H and the duration of submergence. This is shown in Table V.

TABLE V

Initial pH	*pH value on days from flooding*		
	8	*23*	*51*
4·7	5·1	6·2	6·3
5·8	6·3	6·6	6·7
6·7	6·8	6·9	7·0

The increase in *p*H is due largely to the production of ferrous and manganous hydroxides. When a rice soil dries these compounds take up oxygen and are converted to the insoluble oxidized forms. The *p*H value then decreases. These reversible *p*H changes in paddy soils were first reported by Dennett (13).

The *p*H value *per se* of the soil probably has little effect on the rice plant. The secondary effect of the *p*H of the soil may, however, be considerable.

A low *p*H favours the presence of excessive amounts of iron and manganese in the soil solution. Besides, it may

retard considerably desirable microbiological transformations such as the destruction of butyric acid and ammonification of organic nitrogen. It is interesting to note in this connection that "Japanese farmers have laid more importance to the application of lime to paddy rice field than to the upland" (32) and that dramatic responses to lime have been reported on the acid rice soils of Taiwan (10).

Decrease in Redox Potential. The redox potential of soil decreases on submergence. The fall in potential, especially in the early stages, is marked if readily decomposable organic matter is present. Accompanying the fall in potential is an increase in the concentration of reduced substances such as ferrous iron, manganous compounds, and sulphides. The drop in potential and the release of soluble iron, particularly, is considerably retarded by the presence of nitrate. The highest yields in a green house experiment were found to be associated with the treatments which by virtue of the presence of nitrate maintained their redox potentials at a high level for a good part of the growing season (37).

In acid soils where iron toxicity may be a problem it may be desirable to make heavy applications of lime, preferably a few weeks before flooding. The accumulation of nitrates and the increase in pH following liming should cause a marked reduction in the amount of iron brought into solution.

Increase in Electrical Conductivity. The electrical conductivity of a soil initially low in nitrate and sulphate will increase on submergence, the increase being due largely to the release of iron and manganese ions. But in view of the complications caused by denitrification, sulphate reduction, and assimilation of ions by the rice plant it is doubtful whether electrical conductivity will be of much use in the study of rice soils.

Literature Cited

1. ACHARYA, C. N. Studies on the anaerobic decomposition of plant materials. I. Anaerobic decomposition of rice straw. *Biochem, Jour.* 29 : 528-541. 1935.

2. ACHARYA, C. N. Studies on the anaerobic decomposition of plant materials. II. Some factors influencing the anaerobic decomposition of rice straw. *Biochem. Jour.* 29 : 953-960. 1935.

3. ACHARYA, C. N. Studies on the anaerobic decomposition of plant materials. III, Comparison of the course of decomposition under anaerobic, aerobic, and partially aerobic conditions. *Biochem. Jour.* 29 : 1116-1120. 1935.

4. AOKI, MOICHI, Studies on the behaviour of soil phosphoric acid under paddy field conditions. *I. J. Sci. Soil Man. Japan.* 15 : 182-202. 1941.

5. BARTHOLEMEW, R. P. The availability of nitrogenous fertilizers to rice. *Soil Sci.* 28 : 85-100. 1929.

6. BARTHOLEMEW, R. P. Changes in the availability of phosphorus in irrigated rice soils. *Soil Sci.* 31 : 209-218. 1931.

7. BONNER, J. The role of organic matter, especially manure, in the nutrition of rice. *Bot. Gaz.* 108 : 267-279. 1946.

8. BONNER, J. Plant Biochemistry. *Academic Press Inc. New York,* 1950.

9. CHANG, H. T. and LOOMIS, W. E. Effect of carbon dioxide on absorption of water and nutrients by roots. *Pl. Phys.* 221-232. 1945.

10. CHANG, S. C., and HUNG, K. S. Demonstration on liming the acid paddy soils for the second crop of 1950 and the first crop of 1951. *Agri. Res. (Taiwan)* Vol. 2, No. 3. 48.52. 1951.

11. DE, P. K., and SARKAR, S. N. Transformation of nitrate in waterlogged soil. *Soil Sci.* 42 : 143-155. 1936.

12. DE GEE, J. C. Preliminary oxidation—potential determination in a "Sawah" profile near Bogar (Java). 4th Int. Cong. *Soil Sci. Trans.* 1 : 300-303, 1950.

13. DENNETT, J. H. A preliminary note on the reaction of padi soils. *Malay. Agric. Jour.* 20 : 518. 1932.

14. DOMI, Y., SUGAYA, T., KOSHIIZU, Y., and MURAKAMI, S. Studies on the effect of ammonium salts on rice roots. (1) Growth of roots and protoplasmic streaming. *Proc. Crop. Sci. Soc. Japan.* 19 : 194-197.

15. GILE, P. L. and CARRERO, J. O. Assimilation of iron by rice from certain nutrient solutions. *J. Agric. Res.* 7 : 503-528. 1916.

16. GILE, P. L. and CARRERO, J. O. Cause of lime induced chlorosis and availability of iron in the soil *J. Agric. Res.* 20 : 33-62. 1920.

17. GERICKE, W. F. Plant food requirements of rice. *Soil Sci.* 29 : 207-227. 1930.

18. HARRISON, W. H. and AIYAR, P. A. S. The gases of swamp rice soils. I. Their composition and relationship to the crop. *Mem. Dept. Agric. Ind.* 3 : 65-104. 1913.

19. HARRISON, W. H. and AIYAR, P. A. S. The gases of swamp rice soils. II. Their utilization for the aeration of the crop. *Mem. Dept. Agric. Ind.* 4 : 1-18. 1915.

20. ISHIBASHI, H. On the relation between the effect of silica and nitrogen, silica and phosphorus in the nutrition of rice plant. *J. Sci. Soil Man.* 13 : 217-242. 1939. 1928.

21. JANSSEN, G. and METZGER, W. H. Transformation of nitrogen in rice soil. *J. Amer, Soc. Agron.* 20 : 459-476. 1928.

22. JOACHIM, A. W. R. and KANDIAH, S. Laboratory and field studies on green manuring under paddy-land (anaerobic) conditions. *Trop. Agric.* 71 : 253-271. 1929.

23. JULIANO, J. B. and ALDAMA, J. Morphology of Oryza Sativa L. *Phil. Agric.* 26 : 1-76. 1937.

24. KAPF, L. C. Preliminary report on the effect of certain chemicals on rice production and on their effect on the rice soil. *Ark. Agric. Exp. Sta. Bull.* No. 277. 1932.

25. KAPF, L. C. Study of relation of growth to nutrition of the rice plant. *Ark. Agric. Exp. Sta. Bull.* No. 335. 1936.

26. KELLY, W. P. The function and distribution of manganese in plants and soils. *Hawaii Agric. Exp. Sta. Bull.* No. 26. 1912.

27. KOENIGS F. F. R. A "sawah" profile near Bogor (Java). *Trans. 4th Int. Congr. Soil Sci.* 1 : 297-300. 1950.

28. KUMADA, K. J. *Sci. Soil Manure,* 19 : 119-124. 1949. (Cited by S. Mitsui in Inorganic Nutrition, Fertilization, and Soil Amelioration for lowland rice, *Yokendo Ltd. Tokyo.* 1954.)

29. LIN CH' WAN-KWANG. Effect of oxygen and sodium thio-glycollate on growth of rice. *Pl. Phys.* 21 : 304-318. 1946.

30. MALAVOLTA, E. Studies on the nitrogenous nutrition of rice. *Plant Phys.* 29 : 98-99. 1954.

31. MCGREGOR, A. J. Phosphate movement and natural drainage. *Jour. Soil Sci.* 4 : 86-97. 1953.

32. MITSUI, S. Inorganic nutrition, fertilization and soil amelioration for lowland rice. *Yokendo Ltd. Tokyo.* 1954.

33. MORTIMER, C. H. The exchange of dissolved substances between mud and water in lakes. *Jour. Ecol.* 29 : 280-329. 1941.

34. MORTIMER, C. H. The exchange of dissolved substances between mud and water in lakes. *Jour. Ecol.* 30 : 147-199. 1942.

35. OKAWA, K. and TANAKA, R. The relation between silicic acid and nitrogen; silicic acid and potash on rice. *J. Sci. Soil Man.* 16 : 411-422. 1942.

36. PEARSALL, W. H. The soil complex in relation to plant communities. I. Oxidation-reduction potentials in soils. *Jour. Ecology.* 26 : 180-193. 1938.

37. PONNAMPERUMA F. N. The chemistry of submerged soils in relation to the growth and yield of rice. Cornell University Ph.D. Thesis, 1955, on file with University Microfilms Inc., Ann Arbor, Michigan, U. S. A.

38. PONNAMPERUMA, F. N., BRADFIELD, R., and PEECH, M. Physiological disease of rice attributable to iron toxicity. *Nature* 175 : 265. 1955.

39. RAALTE, M. H. VAN. On the oxygen supply of rice roots. *Ann. Bot. Gard. Buitenzorg.* 51 : 43-57. 1941.

40. REED, F. J. and STURGIS, M. B. A study of the fertilization of rice. *Louisiana Bull.* No. 292. 1937.

41. RUSSEL, E. W. Soil conditions and plant growth. *Longmans, Green and Co., London.* 1950.

42. SETHI, R. L. Root development of rice under different conditions of growth. *Mem. Ind. Dept. Agric. Bot. Ser.* 18 : 57-80. 1930.

43. SHIOIRI, M. and TANADA, T. The chemistry of paddy soils. *Int. Rice Comm. Working Paper* 43. 1952.

44. SIRCAR, S. S. G., DE, S. C. and BHOWMICK, H. D. Microbiological decomposition of plant materials, I. and *Jour. Agric. Sci.* 10 : 119-151 1940.

45. SIRCAR, S. S. G., DE, S. C. and BHOWMICK, H. D. Microbiological decomposition of plant materials. II. A note on the changes in the methoxyl and nitrogen content of lignin of rice straw during its decomposition by microorganisms. *Ind. Jour. Agri. Sci.* 10 : 152-157. 1940.

46. SREENIVASAN, A. Investigation on the role of silicon in plant nutrition. Part IV. Effect of silicate fertilization on the growth of the rice plant and yield of paddy. *Proc. Ind. Acad. Sci. Sec. B.* 3 : 302-309. 1946.

47. STURGIS, M. B. Changes in the oxidation-reduction in soils as related to the physical properties of the soil and the growth of rice. *Louisiana. Bull.* No. 271. 1936.

48. SUBRAHMANYAN, V. Some aspects of the chemistry of swamp soils. *Current Sci.* 5 : 656-659. 1937.

49. SUZUKI, H. Studies on the influence of some environmental factors on the susceptibility of the rice plant to Blast and Helminthosporium diseases and on the anatomical characters of the plant. II. Influence of differences in soil moisture and in the amount of nitrogenous fertilizer given. *Jour. College Abric. Tokyo Univ.* 13 : 236-275. 1935.

50. THELIN, G. and BEUMONT, A. B. The effect of some forms of nitrogen on the growth and nitrogen content of wheat and rice plants. *Jour. Amer. Soc. Agron,* 26 : 1012-1017. 1924.

51. VLAMIS, J. and DAVIS, A. R. Effect of oxygen tension on certain physiological responses of rice, barley, and tomato. *Plant Phys.* 19 : 33-51. 1944.

52. YAMADA, N. and IYAMA, J. Study on the respiration of crop plants. (3). Gas contained within the rice plant with special reference to the gas in the root. *Proc. Crop. Sci. Soc. Japan.* 21 : 197-198. 1953.

53. YARKOV, S. P., KULAKOV, E. V. and KAURICHEV, S. The formation of ferrous iron and the peculiarities of the phosphate regime in sod-podzolized soils. *Pochvovedenie* 1950, 466-475.

54. YOSHII, H. Studies on the nature of rice blast resistance. *Bull. Sci. Fak. Terkult. Kyusu Imp. Univ.* 9 : 291-307. 1941. (*Biolog. Abs.* 16 : 1657.)

Coffee—Its Cultivation and Curing

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Introduction

ALL VARIETIES of coffee are native to different regions of Africa and have probably been used as a drink by the inhabitants of these countries from early times. Coffee, as a beverage, however, only came to the notice of the rest of the world after its introduction into Arabia somewhere about the 4th century, and its cultivation as a plantation crop dates from the 17th century. From small beginnings, the use of coffee as a beverage, and its cultivation on a plantation scale have spread to such an extent, that at the present day it is cultivated throughout the tropics, and in world trade is reported to be commercially more important than either tea or cacao, the two other important beverages. Brazil is the largest coffee producing country in the world, but the crop is grown to a fairly large extent in other parts of South and Central America, as well as East and West Africa, India and Indonesia, while smaller producing countries such as Jamaica are justly famous for the excellent quality of their produce.

It is likely that Arab traders had introduced the coffee plant into Ceylon even before Portuguese times, but large-scale cultivation in Ceylon dates from 1825 when Sir Edward Barnes, Governor of the Island, opened a coffee estate at Gannoruwa on the present site of the Experiment Station at Peradeniya (1). From this beginning, coffee cultivation expanded so rapidly in Ceylon that by 1867 it was estimated that about 125,000 acres were under the crop and considerable quantities of coffee were being exported. This was, however, the peak of the coffee 'boom' for in 1869 the coffee leaf rust, caused by the fungus *Hamileia vastatrix*, was first noted in Ceylon (2). The disease spread so rapidly and caused such destruction that within a brief period of about 20 years coffee cultivation was no longer one of the major planting industries of Ceylon, and attention was being turned to tea. Although the collapse of the coffee industry is blamed on the fungus which caused the leaf disease, it is possible that faulty land usage, leading to erosion and soil acidity in a tropical climate with high rainfall, may have contributed to declining yields, as the coffee plant is known to be highly sensitive to soil reaction. Whatever the cause of the collapse, however, in 1953 it was estimated that only 47 acres were under coffee in Ceylon, while imports of coffee in 1953 amounted to 1,074,090 lb., valued at Rs. 2,658,720 (3). With the availability of rust-resistant varieties and with a better appreciation of land use methods, there is no reason why coffee should not once more be cultivated successfully in Ceylon. Such is the view of practical planters, and the volume of applications for planting material indicate increasing interest in coffee cultivation. It is with the idea of providing some basic information for those interested in coffee cultivation that this article is being published.

Varieties

In its native habitat, coffee is an evergreen bush or small tree, growing under the shade of other tropical forest trees. But although the coffee plant was first described by Linnaeus and assigned to the family Rubiaceae as far back as 1753, up to date the classification of the genus *coffea* remains confused and unsatisfactory. Commercially many varieties are described, but botanically all these varieties fall into five fairly distinct species, each species containing numerous subspecies and varieties (4).

(i) *Coffea arabica*—**Arabian coffee.** Up to the time that the leaf disease destroyed the coffee industry of the East, *arabica* was the only species cultivated, and even now this species produces the greater part of the world's output. It grows wild in the subtropical highlands of Ethiopia. In Ceylon, arabian coffee is most likely to thrive at elevations over 2,500 feet under shade. It produces coffee of the best quality. The species includes a number of varieties such as Maragogie and Nacional of Brazil, Bourbon of Martinique, Erecta and Padang of Indonesia, Moka or Mokka of Yemen in Arabia, and the famous Blue Mountain Coffee of Jamaica.

(ii) *Coffea liberica*—**Liberian coffee.** This is a lowland variety of coffee, indigenous to West Africa, and is more suited to the high temperature and humidity of the low country of Ceylon. It is a large, vigorous tree, capable of growing without shade, and fairly resistant to leaf disease. Experience in Indonesia, however, has shown that this resistance sometimes breaks down. Another disadvantage is the poor quality of the produce. The species includes such varieties as Klainii, Excelsa, Arnoldiana and Abeokutae.

(iii) *Coffea robusta* (*C. canephora*) —**Robusta coffee.** It is a lowland coffee, thriving from sea-level to 2,000 feet under Ceylon conditions, but needs shade for its successful growth. The species is resistant to leaf disease, and has the added advantage that ripe berries are held on the tree. The quality of the cured beans is said to be inferior to that of *arabica,* but superior to that of *liberica,* and in marketing is used for blending with *arabica,* to give the latter coffee added "body". The species includes varieties such as Kouilou or Quillou, Congo and Uganda.

(iv) *Coffea stenophylla*—**Sierra Leone coffee** or **Rio Nunez coffee.** This species is a medium elevation coffee, growing into a medium sized tree with small, leathery leaves, which are very resistant to leaf disease, and distinguished from other species by bearing small, ovoid berries which ripen black. The cured beans have a characteristic odour, but the quality is said to be good, although this species is not grown extensively.

(v) *Coffea congensis*—**Congo Coffee** or **Shallot coffee.** The species is of no commercial importance.

In addition to the above species, numerous hybrids bred for qualities such as rust-resistance exist.

Climate and Soil Requirements

From a study of the climates of the different native habitats of species of coffee, it appears as if temperature controls the altitude at which coffee can be grown successfully. *Arabica* coffee,

which has its origin in the highlands of Ethiopia with a subtropical climate, does best at the highest elevations. Thus, an elevation of 4,500-6,500 ft. with a temperature of 64°F.—69°F. is considered best for *arabica* coffee in Kenya (5). In Ceylon, *arabica* coffee has been found to grow best at elevations over 2,000 ft. On the other hand, *liberica* and *robusta* coffees grow wild in tropical lowlands where the temperature rarely falls below 80°F., and as such are suited to lower altitudes. In Ceylon these two species thrive from 0—2,000 ft. Wide variations in temperature are unfavourable to the crop, although slight seasonal fluctuations in temperature, humidity and rainfall influence flowering and fruiting. It should also be borne in mind that the general climate of an area can be considerably modified by factors such as the slope of the ground, spacing of the bushes, pruning, shade, windbreaks, cover crops and mulches (6). It has also been thought that elevation has an effect on the quality of the crop ; the higher the elevation the better the quality (7).

The rainfall requirements of the coffee crop have to be considered not only from the point of view of the requirements of the growing plants, but also from the point of view of flowering, berry formation and ripening, and curing of the harvested crop. As regards the growing plants, 70-80 inches of rain, well distributed over the year with no long spells of drought, is best. At the same time yield depends to a large extent on rainfall at and after flowering, as will be explained under the section on harvesting and yields. Protection from strong winds is also essential.

Coffee can be cultivated on a variety of soils as long as they are not very gravelly or sandy or rocky, and are not heavy clays. Experience has indicated that, although soils of good to average fertility are preferred, the physical properties of the soil are more important than the chemical—depth, good drainage and sufficient aeration being especially important. For optimum growth the soil should, in addition, be neutral in reaction and never very acid.

Opening Up of Land

On land which is being newly opened up for coffee cultivation, it is essential that measures to conserve the soil be taken from the outset. Otherwise costs of manuring and liming are bound to increase from year to year, in a continual battle against deteriorating yields. Soil conservation is especially important during the first few years of a plantation, because in later years the coffee trees themselves as well as the shade trees provide a certain amount of protection to the soil.

Very steep land should not be planted in coffee at all, but gently sloping and undulating land is very often preferred because of good drainage conditions that obtain on such land. Since platform terracing is usually too expensive a practice, broad-based ridge terraces, either on the contour, or if the soil is impervious and rainfalls of high intensity are experienced, on a gentle gradient, seem to be sufficient for gently sloping land. Whatever mechanical measures for soil conservation are chosen, silt pits, drains, bunds or terraces, they should be supplemented from the very beginning with contour hedges of suitable bush green manures,

and cover crops. Many of the *Crotalarias* and *Tephrosias* are suitable for contour hedges, while any of the commoner cover crops such as *Calapagonium mucunoides, Pueraria phaseoloides* and *Desmodium ovalifolium* serve for low cover. Naturally occurring weeds could also be used as covers as long as grasses and deep-rooted herbs are avoided, but in the long run it is cheaper to establish a good leguminous cover from the start.

The coffee should be planted on the contour and spacing for holes should be adopted with this in mind. With *arabica* varieties of coffee a spacing of 6-8 ft. between trees appears suitable, while with *robusta* varieties the standard spacing is 12 ft. Liberian varieties are more vigorous growers and become larger trees ; they consequently require a wider spacing of about 20 ft. The usual size of hole dug for establishing coffee seedlings is 2 ft. square by at least 2 ft. deep. Such holes should be opened up at the required spacing, and left open for as long a period as possible to allow the bottom and sides of the holes to weather, before being filled up. They should subsequently be filled with a mixture of top soil and well rotted cattle manure or compost, heaped to a point in the centre, marked with stakes, and left to settle before planting.

The establishment of some form of shade is usually required for the successful cultivation of coffee, and it is usual to establish such shade well in advance of the time of planting, so that the young transplanted coffee will benefit from it. Temporary low shade is also advantageous to the young coffee, and this is best provided in the form of *Crotalaria brownei* or *Crotalaria striata* grown in rings round the planting holes. Such shade should be established at least one year ahead of the probable transplanting date. Temporary shade can be also provided by a catch crop of bananas.

Propagation

The usual method of propagation of coffee is as yet by seed. Seed for planting should be extracted either in small hand pulpers or by treading under foot. The seed should then be sifted by floating in water and removing all "floaters" or light seed, and allowed to dry in the shade. It is sometimes a practice to mix wood ashes with the seed while it is drying, to combine with the sugary matter of the parchment and form a coating which prevents premature splitting of the parchment (8).

The seed is first germinated in sand beds and then transplanted into nurseries. In the former the seed is spaced about an inch apart and pressed down to a depth of about half an inch, then covered with a mulch of straw or cut grass and kept regularly watered. As soon as germination commences, in about four weeks time, the mulch is removed and overhead shade substituted. When the seedlings are 2-3 inches tall they are transplanted into the nursery beds.

Since the seedlings are to remain for about a year in the nursery beds, the latter should be carefully made by digging the soil well to a depth of at least 12 inches, removing all stones, roots and other debris, preparing the soil to a fine tilth and incorporating well rotted cattle manure or compost. The beds should be 3-5 feet wide, 4-6 inches high and of any convenient length. They should be provided with overhead

shade in the form of cadjans or bamboo slats to permit chequered light. The seedlings should be carefully uprooted and transplanted into the nursery beds at a spacing of 6 inches. At first, watering is done at least twice a day with a fine rose, but gradually both watering and shade are reduced to harden the seedlings, till shade is completely removed about a month before the seedlings are to be transferred to the field. Basketed plants can also be raised by transferring the new seedlings from the germinating beds into the baskets instead of into the nursery beds. Subsequently, these basketed plants are treated in the same manner as seedlings in nursery beds. Seedlings are ready for transfer to the field at any time from 6 months to 2 years, but if they are older than one year they should be treated as stumps, and stems and roots pruned back before planting out.

Coffee trees grown from seed vary considerably in their yield capabilities. By establishing vegetatively propagated plants of high yielding clones, an even stand of high yielding coffee trees is attainable. Other advantages in the use of vegetatively propagated planting material are that the ripening period becomes more closely defined and, as such, economy of labour is a possibility, while the use of vigorous resistant root-stocks for budding or grafting enables the plants to withstand the attack of such pests as nematodes. But vegetative propagation has not as yet become an established practice under estate conditions, probably because high yielding clones are not as yet available, and the information on the subject is limited. In Kenya it has been established that hard-wood cuttings could be easily and successfully grown in the open in areas of high rainfall and generally forcing conditions, but that soft-wood cuttings require special propagating chambers (9). Cuttings should always be taken from upright suckers growing from the base of trees and never from lateral branches. In India soft-wood single node cuttings have been established successfully, and the nutritional status of the shoots at the time of extracting cuttings has been shown to be important (10). The rooting medium for cuttings is usually sterilized sand and forest loam. Work in Costa Rica has indicated that the type of rooting medium could have an effect on the type of root system and the subsequent success of the tree (11). Layering, marcotting and inarching could very likely be practised with success, but would be too slow and too wasteful of material to be adopted on a large scale. In Indonesia, grafting is popular, but no information is available on the details of procedure (12). Care should, however, be taken in establishing such vegetatively propagated plants on an estate scale, as work in Indonesia has shown that certain clones of *robusta* coffee are self-sterile, and large plantations of one such alone may give reduced yields (13).

Planting Out

Transplanting seedlings from the nursery into the field is done carefully in rainy weather. In the process all seedlings with deformed and twisted roots should be discarded, and if the tap root is too long and whippy it may be pruned back. To prevent excessive transpiration of the seedlings soon after transplanting, it is usual to cut all leaves in half, although this is not essential in

high rainfall areas. Young seedlings need a certain amount of shade and this should be provided in the form of *kakilla* or other jungle fern, or as described earlier under the section on opening up of land.

Vacancies should be supplied as soon after transplanting as possible, and should subsequently become a routine operation once a year. Where vacancies are being supplied in old coffee, the pits should be larger than usual and a fertilizer mixture should be given to enable the seedlings to grow rapidly and compete successfully with adult trees.

Shade

It has been shown by experiment that the efficiency of the leaves of the coffee plant in manufacturing food is at a maximum under diffused sunlight, and is reduced in intense sunlight as well as under excessive shade (14). Practical experience has also shown that the correct degree of shade is essential for the successful cultivation especially of *arabica* and *robusta* coffees, whereas liberian varieties can do with little or no shade. The provision of overhead shade has the added advantage that it aids in conserving the soil and can be made to serve as a wind-break, while it also provides plenty of loppings for green manurial purposes. The incidence of pests and diseases is also reduced in coffee growing under the appropriate degree of shade.

It is very important that the most suitable shade tree be selected for cultivation, keeping in mind the type of coffee grown and the climatic conditions of the area. Other considerations that should be kept in mind in selecting a variety of shade tree are rapidity of growth, a root system which competes little with the coffee crop for soil moisture and nutrients, and freedom from pests and diseases. *Albizzias, Erythrinas, Grevilleas* and *Gliricidia* are all used as cover, but under Peradeniya conditions *Leucaena glauca* has proved the most suitable. One disadvantage of this variety is that it does not root readily from cuttings and has to be established as seedlings. Other varieties which might prove suitable are *Derris dalbergioides, Derris robusta* and *Indigofera teysmanii.* Shade should be kept under control by periodic lopping, and the loppings used as mulch or green manure. The possibility of using bananas as a catch crop and as temporary shade for the first few years of a plantation should be borne in mind.

Soil Management

The establishment of a thick leguminous ground cover as early as possible, especially on newly opened land, is very important from the point of view of soil conservation. But it is as important in older coffee from the point of view of adding soil nutrients and weed control. Once the coffee and overhead shade are both well grown, it becomes more difficult to maintain a satisfactory cover, but by this time the shade provided by the trees themselves suppress weeds and protect the soil. During the first few years of a plantation it is also sometimes the practice to grow bushy leguminous green manure plants in strips between the rows of coffee. These are used as mulch or forked in periodically.

In areas which experience a fairly prolonged dry period, the cover crop,

bushy green manure and the shade trees may compete with the coffee for soil moisture, and this has to be guarded against. Investigations carried out in Kenya have shown that loss of soil moisture under such conditions was greatest with a vigorously growing cover crop, but least with a grass mulch (15). Thus, it is the practice under such climatic conditions to use the cover crop, bushy green manure and loppings from shade trees as cut mulch at the commencement of the dry period and then fork them in at the time of manuring, when the material will have rotted down and when the manuring will ensure that even a temporary state of nitrogen deficiency, due to the incorporation of highly carbonaceous material, will not take place. Guatamala grass has also been used with success as a mulching material.

No implemental cultivation, other than hand-forking, is carried out under local conditions.

Pruning

Coffee bears two kinds of branches, viz., (*a*) uprights which can produce other uprights and also laterals, and (*b*) laterals which can only produce laterals of a lower order but never give rise to uprights. In addition, the lateral branches of various orders as well as the leaves are borne in opposite pairs. This peculiar branching habit and the fact that flowers and fruits are borne only on young lateral-branch wood, determines the pruning of the coffee bush.

The purpose of pruning is to get rid of superfluous, unproductive wood from the coffee tree, and thus direct the vigour of the tree into producing more young lateral-branch wood which bears the crop. At the same time pruning aims at removing all diseased wood, and allowing light and air to penetrate the bush, while under certain systems of pruning another aim is to keep the bush down to a height within easy reach for harvesting. There are two main systems of pruning—the single-stem system and the multiple-stem system—each with its different modifications.

Single-Stem System. In this system, after the first year, all upright suckers or 'gormandizers' which grow from the bottom of the plant are continuously broken off while still tender and green. When the plants are about 6 ft. tall they are cut back or 'topped' at a height of about 4½ feet, removing with a slanting cut one primary lateral branch at the point of origin of a pair. This branch is removed to prevent the main stem from splitting down the middle due to the weight of two opposite branches. Pruning of lateral branches only becomes necessary in the third to fifth year of growth. Primary laterals are never touched, while the practice is to remove one of each pair of secondary and tertiary laterals alternately. At the same time, 'centering' or the removal of all suckers and secondary wood in close proximity to the main stem is carried out.

Multiple-Stem Systems. Although single-stem pruning is the method almost exclusively practised in Ceylon, various modifications of multiple-stem systems of pruning have come into prominence in other countries and merit attention if coffee is to be grown on a commercial scale in Ceylon too, especially as it has been claimed that the latter method produces more crop than

the former, while being less complicated and expensive (16). In one variation of the multiple-stem system, the young plants are topped at 12-15 inches and then again at about 36 inches from ground level, so that the tree develops four lateral branches. In the third year after transplanting the weakest of these four branches is removed and the three remaining branches are trained to form the permanent framework of the tree. This system of pruning is very similar to the single-stem system, the berries being still borne on secondary and tertiary lateral branches, except that the framework of the tree is supported by three branches instead of by one stem only. But other variations of the multiple-stem system of pruning are radically different in that bearing takes place on primary branches, which are constantly and regularly renewed, and no attempt is made to keep the bush down to a low height. In all cases, when one sucker has borne two to three crops it is removed and replaced by another which has been trained in the meantime. In this manner a large and regular supply of young wood is ensured, on which the tree bears large crops. One disadvantage of this method of pruning, however, is that cost of harvesting is high, since step-ladders may have to be used to pick the berries.

Stumping or 'rejuvenation pruning' is sometimes practised to develop a completely new aerial part of the tree on the old root-stock, or to convert single-stem trees into a multiple of stems. In such cases a sloping cut is made at the required height close to ground level and immediately dressed over with some wound disinfectant. Sucker growth soon takes place, and when one or more suckers have been selected the others are removed while still green and tender. In drier areas it is sometimes the practice to modify this method of stumping. All the primary branches on the stem, except for a few at the top of the tree, are removed flush with the stem. These latter serve to shade, and so encourage, the growth of a number of suckers from the base of the stem. When these latter are sufficiently grown, a selection is made as desired and the original stem removed as before (17).

All superfluous sucker growth should be removed when green and tender, but more mature wood should be carefully pruned with pruning knife or saw without leaving any snags. The best time for pruning is soon after the main fruiting season.

Manuring

There is little precise information on the manurial requirements of the coffee tree, except for the belief that it requires comparatively large quantities of nitrogen and potash but little phosphate, and manurial practices vary widely. But, as in other crops, if the best results are to be expected from the addition of expensive fertilizers, attention should first be paid to conservation of the soil and soil moisture, and to maintaining the good physical structure of the soil together with a good proportion of organic matter.

Most of the above requirements are met by the addition of organic matter to the soil, and the mulching and incorporation of the loppings of shade trees, green manures and cover crops should be carried out as a routine operation. When bulky plant residues are to be

incorporated into the soil it should be done in rows across the slope of the land. Compost, if available in sufficient quantity, may be applied at the rate of 2-2½ tons per acre; but if only available in limited quantity, as is often the case, is better utilized in backward areas which require it most.

In addition to the application of organic manures, the regular application of more concentrated and more readily available inorganic fertilizers is a necessity if the maximum yield is to be obtained. In the absence of experimental data under local conditions, no specific manurial recommendations can be made, but the following general fertilizer mixture per acre per annum, which is used at the Experiment Station, Peradeniya, seems to compare well with those recommended in other countries.

Sulphate of ammonia— 2 cwt.

Saphos phosphate— ½ to 2 cwt.

Sulphate of potash— 1 cwt.

On estates in which regular manuring has been done, there will usually be a tendency for residual phosphates to accumulate in the soil, and under such conditions this constituent in the mixture may be reduced to ½ cwt. per acre. The sulphate of potash is preferable to the muriate where the quality of the crop is important, as in coffee. The above mixture is preferably added in two doses, one in May or June and the other in December. If it has to be applied as one dose for the sake of economy, May or June is the best time. In adult coffee the mixture is enveloped, forked or broadcast and turned in. In young coffee it is best distributed in expanding circles round the tree.

In very rainy districts, soils tend to become acid and coffee does not thrive under such conditions. As such, periodic liming may become necessary. The lime requirement should be determined in consultation with a soil chemist.

Coffee may also at times show signs of chlorosis and yellowing, owing to either a deficiency of nitrogen in the soil or to more deep-seated causes arising from poor soil moisture conditions or nutritional unbalance in the tree caused by bad conditions of shading. Chlorosis caused by nitrogen deficiency is usually temporary and easily remedied with a special top-dressing of sulphate of ammonia at the rate of 1—2 cwt. per acre. The second type of chlorosis is more difficult to remedy and should be treated by attention to the shade, and stripping of the berries from trees which appear unable to stand the strain of bearing a large crop.

Harvesting and Yields

Under normal conditions trees begin to flower and bear fruit for the first time in about the third year from planting, but economic crops only begin to be realized after about the sixth year. The economic life of the coffee tree is generally considered to be from 30-50 years, depending mainly upon climate, but under good conditions of cultivation it may be prolonged beyond this.

Yield is seen to depend to a large extent on weather conditions at and after flowering, dry weather favouring flower bud or "spike" formation, but rain being generally required to induce the flower buds to blossom. Dry weather again seems to be required at flowering to ensure fruit setting, while a constant supply of moisture is needed by the young berries which have set and

begun to grow until ripening (18). The time taken from flowering to ripening depends on climate and variety, and in Ceylon the main fruiting season is from September to January with the *arabica* variety fruiting first, followed by *robusta* and then by *liberica*.

The fruit of the coffee tree—the berry or 'cherry'—usually contains two seeds, but sometimes only one of them develops at the expense of the other, giving rise to one large 'peaberry". Fruits with four or more seeds—'plurisperm fruits'—may also be borne.

Harvesting of berries is done by hand, only ripe berries being picked ; three to six pickings are necessary to complete a harvest. If immature berries are harvested and mixed with ripe ones, pulping becomes difficult and gives a high degree of breakage, while fermentation is also uneven, and the quality of the produce is impaired. Yields vary according to climate, variety and cultural conditions. In Ceylon *robusta* coffee yields 13-16 cwt. of fresh berries per acre. As the out-turn of parchment coffee from fresh berries is about 25-30 per cent. the yield should vary from 3 to 6 cwt. of parchment coffee per acre per annum.

Preparation for Market

To obtain commercial coffee the beans must be freed from the pulp, the 'parchment' and the 'silver skin'. Cleaning and grading then complete the process. There are two methods of preparation, the wet and the dry. The small grower usually prefers the dry method because it is simpler and cheaper, no elaborate and expensive equipment being required, and because it allows for mixed berries of different stages of ripeness to be treated together. But this method has the disadvantage that it is only practicable where the dry season is sufficiently long and coincides with the time of ripening. The trade, however, prefers coffee produced by the wet method as the product is cleaner and more uniform. On a plantation scale the latter method is usually preferred, as the initial outlay on equipment is compensated for by the better price fetched from coffee prepared in this way.

Dry Curing. In the dry method, the berries are exposed to the sun in thin layers 3-4 inches thick on a drying floor for 10-12 days, being constantly turned during this period. The berries may sometimes be graded before being sun-dried, the ripe berries which settle to the bottom of a water tank being treated separately from the green or withered berries which float. If wet weather is normally experienced during harvesting time, artificial drying may have to be resorted to, but coffee sun-dried at low temperatures is said to possess a better flavour than that dried artifically. Dry-cured coffee stores well, the dried pulp forming a hard protective covering round the beans. Finally, the dried pulp is removed by pounding in a mortar under village conditions or by hulling where larger quantities of berries are processed.

Wet Curing. In the wet method, the day's pick of berries should be pulped as soon as possible, preferably on the day of harvest itself. If this is not possible premature fermentation must be prevented by stacking the berries overnight in a tank of water or in heaps well moistened with water. Before pulping

any stones and grit that are mixed with the berries must be removed to prevent damage to the pulpers. For optimum efficiency of the pulpers, immature berries should be separated ; and if the berries vary considerably in size, two or more size grades treated separately. Pulping is one of the most important operations in the wet preparation of coffee. Ordinary pulping machines are of two different kinds—disc pulpers and breast pulpers. The latter are power-driven and can pulp more coffee in a given time than the former, which can be hand-operated or power-driven. With either kind of pulper, efficiency depends on regular feeding, a good flow of water, exact adjustment of the pulper to suit the size of berry being pulped, and a uniform speed of working. At the completion of each day's pulping the whole machine should be thoroughly washed down. The pulp should not be allowed to go waste, but may be collected, dried and used for manuring the coffee trees.

The next operation is **fermenting.** The need for fermentation arises from the fact that, soon after pulping, the parchment of the beans is covered with a sticky, saccharine slime which has to be removed before drying, or the beans quickly become mouldy in storage and acquire a musty smell. This gummy coating cannot be removed by washing alone, but fermentation causes it to disintegrate when it can be easily removed by washing. Unlike in cacao, fermentation does not seem to have any effect on the quality of the finished product, and it has recently been suggested that an alkaline carbonate could be used to achieve the same ends as fermentation (19), and that pecticenzymes be used to hasten and control the process (20). For a small crop, the pulped beans may be heaped and left covered with gunnies, but for larger crops fermenting boxes or tanks similar to those used for cacao fermentation become necessary.

The pulped berries are drained of water, placed in these tanks, covered and weighted down, when bacterial activity soon commences. The fermenting mass should be stirred and turned frequently to ensure even fermentation. The time taken for the correct degree of fermentation varies with the variety of coffee and the degree of ripeness of the berries at harvesting. A handful of sufficiently fermented beans when squeezed should give a slightly gritty feeling. At Peradeniya, fully ripe *robusta* coffee is fermented for 24-36 hours, but never more than 36 hours, while *arabica* coffee is fermented for a shorter period. Over-fermentation should be prevented at all costs, as this leads to a discolouration of the beans and reduces their value. A similar discolouration may be caused if the berries are left too long before they are pulped.

After the coffee has been adequately fermented it should be thoroughly washed in running water until all the stickiness has disappeared from the beans. This opportunity may be taken to separate light and inferior coffee from the better grades. Imperfect washing can result in fermentation recommencing, while dust and dirt may adhere to the parchment if any of the gummy substance is left on the beans and so again reduce its value. The Raoeng cylinder pulper avoids the necessity for fermentation, the pulping and washing being done in the same

operation by friction under pressure in water. The only apparent disadvantage of the machine is its cost, but this disadvantage seems to be offset by economy in labour and by the rapidity and cleanliness of preparation (21).

The coffee is now in the 'parchment' stage and has to be dried either in the sun or by means of artificial heat. Sun drying can be carried out on barbecues, wire trays, tables covered with jute hessian or on coir matting, but it should be noted that prolonged contact with metallic surfaces while drying is said to impair the quality of the coffee. The coffee should be spread thinly, and raked over frequently to ensure even drying and uniform colour of product. Although overdrying may result in the parchment splitting, the beans shrinking and shrivelling and the coffee becoming pale and discoloured, it is always safer to overdry than to underdry, as undried coffee may blacken in colour, become mouldy in storage and acquire a musty odour. If weather conditions at curing time normally do not permit of sun-drying, the use of artificial heat for drying may have to be resorted to, where like in cacao factories, the beans are spread thinly on lofts and heat conveyed to the lofts from a furnace through flues. The moisture-laden air is kept moving by means of fans. Under such conditions too rapid drying under very high temperatures should be avoided. It is sometimes the practice to sun-dry wet parchment coffee initially and then complete the drying in flue-heated barns.

Coffee is usually stored and sold by the grower as well dried parchment coffee. Milling or hulling, which involves the removal of the parchment and 'silver skin' and a certain amount of polishing, as well as grading are normally performed by firms at the port of export, the chief reason for this being the need for specialized and expensive equipment.

Acknowledgments

My thanks are due to Mr. V. E. A. Wickremanayaka, Lecturer in Agricultural Engineering, University of Ceylon, and former Lecturer in Agronomy, School of Agriculture, for advice on various sections of this paper.

References

1. Tennent, Sir J. Emerson (1860). Ceylon, II : 288. London.

2. Abbay, Rev. R. (1878). Quoted by Morris, D. (1879). "The Campaign of 1879 against coffee leaf disease" : 35. Colombo.

3. Anon (1953). Ferguson's Ceylon Directory, II. Estates Directory : 264. Colombo ; and Ceylon Customs Returns, December, 1953 : 21-22, Colombo.

4. Di Fulvio, A. (1947). "The World's Coffee", III : 43-55. F. A. O. Rome.

5. Walter, A. (1937). "Coffee in Kenya" I : 5. Nairobi.

6. Kirkpatrick, T. W. (1935). "The Climate and Eco-climates of Coffee Plantations", III : 48-63. London.

7. Studer, E. (1953). "Quality Coffee", *Indian Coffee*, XVIII, No. 1 : 10-16.

8. Gillet, S. and T. C. Mc Clelland (1937). "Coffee in Kenya", III : 66-67, Nairobi.

9. Gillet, S. and T. C. Mc Clelland (1937). "Coffee in Kenya", III : 62-63. Nairobi.

10. Sundaram, S. (1953). "Factors favouring rooting of coffee sucker cuttings", *Indian Coffee*, XVII, No. 2 : 31-41.

11. THOMAS, K. M. (1953). "Notes on the visit of Dr. William H. Cowgill and Dr. Frederic L. Wellman". *Indian Coffee*, XVII, No. 2 : 42-48.

12. SNOEP, W. (1940). "Practical application of branch grafting coffee". *Bergcultures*, 14 : 482-91 ; quoted in *Hort. Abs.*, X, 1452 : 365.

13. FERWEDA, F. P. (1932). "Grafting versus seed in coffee", *Bergcultures*, 6 : 629-44 ; quoted in *Hort. Abs.*, II, 385 : 164-165.

14. NUTMAN, F. J. (1937). "Studies of the Physiology of Coffee *arabica*, I : "Photosynthesis of coffee leaves under natural conditions". *Ann. Bot.* I : 353-367.

15. GETHIN JONES, G. H. (1937). Coffee in Kenya", II : 33, Nairobi.

16. GILLET, S. and T. C. MC CLELLAND (1937). "Coffee in Kenya", III : 92-93. Nairobi.

17. GILLET, S. and T. C. MC CLELLAND (1937). "Coffee in Kenya", III : 93-95. Nairobi.

18. WINDLE, E. G. (1933). "Modern Coffee Planting", XI : 90-97. London.

19. DI FULVIO, A. (1947). "The World's Coffee", III : 72. F.A.O. Rome.

20. JOHNSTONE, W. R. and H. E. FOOTE (1951). "A new coffee curing process developed". *Tea and Coffee Trade Journal*, Dec. 1951. Reproduced in *Indian Coffee*, XVI, No. 4 : 69-73.

21. DI FULVIO, A. (1947). "The World's Coffee", III : 72. F.A.O. Rome.

Food Yeast–A Source of Proteins and Vitamins

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Received 26.4.55.

THE AVERAGE Ceylonese diet is reported to be deficient in proteins of high biological value and B vitamins. This deficiency can be remedied by supplementing the diet with small doses of food yeast, which is rich in these constituents. Food yeast contains 5 per cent. moisture, 50 per cent. protein, 2 per cent. phosphorous, 2 milligrammes per cent. vitamin B1, 6 milligrammes per cent. vitamin B2, and 40 milligrammes per cent. of nicotinic acid. It also contains the other members of the vitamin B complex in balanced proportions including minerals like magnesium, potassium, calcium and iron. A daily dose of 3 grammes to 14 grammes of food yeast per person has been recommended by the British Medical Research Council (1).

The production of food yeast was investigated in England by Dr. A. C. Thaysen at the Teddington Research Laboratory. Ultimately, the large-scale manufacture of food yeast was undertaken in a factory in Jamaica. The raw material used was sugar cane molasses (2), (3).

Investigations were conducted in the Chemical Division of the Department of Agriculture, Peradeniya, using coconut water, the dried pulp of the palmyra fruit ("Pinattu") and sugar cane syrup, as raw materials for the production of food yeast.

Laboratory Investigations

A culture of the yeast—*Torulopsis utilis* (variety *major*) was obtained from the Government Mycologist, Coimbatore, India, and maintained by the Plant Pathologist of the Department of Agriculture, Peradeniya.

As many as 40 tube cultures were prepared and allowed to grow for 3 weeks at 25°C. The tubes contained nutrient agar slants of the following composition— 2 per cent. cane sugar, 1 per cent. ammonium nitrate, 0.5 per cent. potassium dihydrogen phosphate, 0.25 per cent. magnesium sulphate and 2 per cent. agar. The tubes were sterilized for half an hour at 15 lb. per sq. in. pressure and allowed to cool before inoculation with yeast.

The yeast from each tube was washed with distilled water into a flask containing 250 c.c. of liquid nutrient medium of the same composition as the nutrient agar but without the agar. The medium was sterilized by boiling and allowed to cool before inoculation with yeast. The 40 flask cultures were shaken once daily for one week.

A laboratory food yeast generator was then assembled. It consisted of the following items :—

1. A cast iron vessel—enamelled inside—of capacity 10 gallons.
2. An electrically operated air blower with air tank, control valves and pressure gauge.
3. Three porous ceramic candles—type Aerox P. 32, fixed at the bottom of the cast iron vessel.
4. An arrangement for purifying air, viz. :
   (*a*) One flask containing glass wool smeared with glycerine to trap dust.

(b) One flask containing concentrated sulphuric acid to destroy bacteria.

(c) One flask containing distilled water to absorb sulphuric acid fumes.

5. A pH meter with antimony electrodes.

6. Sharples Centrifuge.

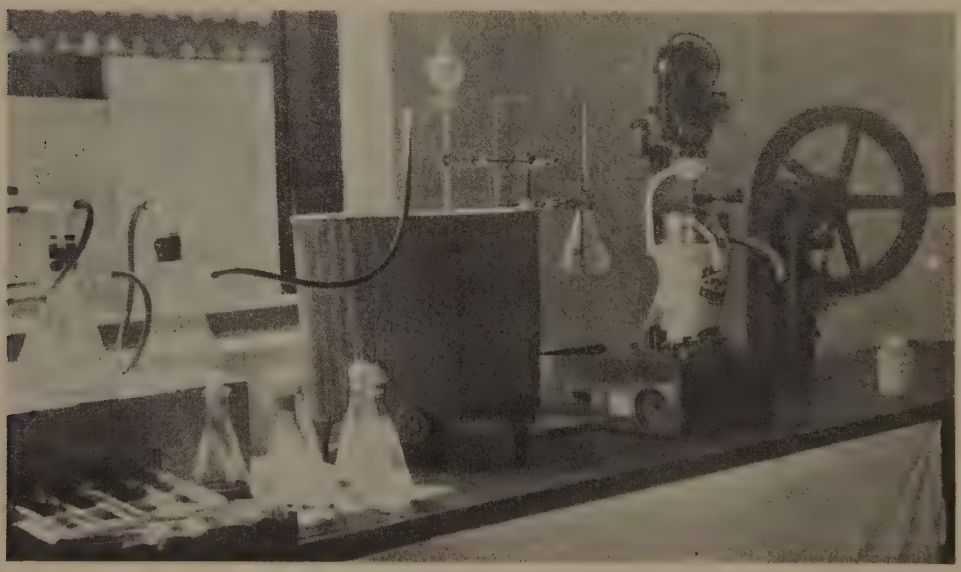
7. A stringhopper mould.

8. An electric oven with fan to create draught.

9. An electric grinding mill.

10. A tablet-making machine.

A photograph accompanying this article, shows the layout of the equipment.



The yeast generated in the 40 flask cultures was poured with the medium into the cast iron enamelled vessel. The pH of the medium was adjusted to 4.8 with 10 per cent. sulphuric acid. The medium containing the yeast was aerated with clean air and the pH which began to fall was maintained at 4.8 by the addition of 10 per cent. aqueous ammonia at half-hourly intervals. The generation was continued for 8 hours. The yeast was then separated from the medium by means of the Sharples Centrifuge. The yeast which was separated in the form of a paste was stored in a refrigerator, to be used as seed yeast in the generation of food yeast from coconut water, "Pinattu" and sugar cane syrup, respectively.

In the case of coconut water, the impurities present were removed by straining through muslin cloth. The sugar content was found to be about 1.5 per cent. The coconut water was diluted with clean water to a strength of 1 per cent. sugar. Five gallons of the

diluted coconut water were treated with 200 c.c. of a solution of ammonium phosphate prepared as follows :—

100 grammes of arsenic free superphosphate of lime were treated with 800 c.c. of water and 1.5 c.c. of concentrated sulphuric acid. The mixture was boiled for half an hour and allowed to settle. The clear supernatant liquid was decanted. To 500 c.c. of this solution was added 50 c.c. of a solution of ammonium sulphate prepared by dissolving 20 grammes of ammonium sulphate in 40 c.c. of water. The precipitate formed was allowed to settle and the clear liquid was filtered and used.

The bulk medium so prepared was sterilized by boiling and allowed to cool. This was then poured into the generating vat. Seed yeast in weight equivalent to 20 per cent. of the total quantity of sugar in the medium, was added. The *p*H was adjusted to 4.8 by adding 10 per cent. sulphuric acid. The medium was then ærated, and the *p*H was maintained at 4.8 by the addition of 10 per cent. aqueous ammonia at half-hourly intervals. The concentration of sugar was maintained at 1 per cent. by the addition of sterilized undiluted coconut water, every hour, until one hour before stopping the generation. The generation was continued for 8 hours. The yeast was separated by centrifuging and washed by mixing with clean water and centrifuged again. The paste of yeast obtained was squeezed through a stringhopper mould on to drying trays and dried to a moisture content of 5 per cent. in an electric oven at 70°C. for 7 hours. Pathogenic organisms that may infect the yeast are destroyed when drying at 70°C.

In the case of "Pinattu" which contains about 50 per cent. sugar, and sugar cane syrup which contains about 70 per cent. sugar, the impurities were removed by dissolving the raw materials in three times the quantity of water by weight. The mixture was brought to the boil and treated with superphosphate of lime in weight equal to 1 per cent. of the sugar present in the raw material. The solution was made neutral to litmus by the addition of 10 per cent. sodium hydroxide. The precipitate formed was allowed to settle on cooling and a clear solution was obtained by centrifuging. The clear solution so obtained was diluted with clean water to give 1 per cent. sugar in the final solution. Five gallons of this solution were treated with 200 c.c. of ammonium phosphate solution as in the case of coconut water described earlier. The process of yeast production was carried out in the same way as described under coconut water.

In the case of all these three raw materials used, it was found that the yields of food yeast were of the order of 45 per cent. to 50 per cent. of the total quantity of sugar used in the generation. This indicated that coconut water, "Pinattu" and sugar cane syrup were all equally suitable for food yeast production.

In the case of "Pinattu"—dried palmyra fruit pulp—it was found that extensive frothing was produced during the generation, due to the presence of small quantities of some unknown froth producing principle. This was overcome by the addition of 0.015 per cent. by volume of oleic acid which is recommended to overcome undue frothing in yeast production (4).

The food yeast produced from these three raw materials had, at a moisture level of 5 per cent., protein contents

ranging from 46 per cent. to 52 per cent. The vitamin B1 contents were in the order of 2 milligrammes per cent. to 4 milligrammes per cent.

The dried food yeast produced was ground into a powder by means of the electric grinding mill and converted into tablets by means of a tablet-making machine.

Factory-scale Production

The manufacture of food yeast on a large scale in Ceylon depends primarily on the availability of a cheap raw material containing sugar. Coconut water is available as a by-product in the copra-producing centres in the Western and North-Western Provinces. The water from as many as a million nuts per day would be required to operate the smallest commercial plant producing 1,000 pounds of food yeast per day. It may be feasible to collect the required quantity of coconut water from a number of copra factories in a large centre, to feed the food yeast plant. The plant alone may cost nearly five lakhs of rupees. The building might cost about 2 lakhs of rupees, together with other ancillary units.

Dried palmyra fruit pulp, "Pinattu", can be produced in large quantities in the Jaffna District at a nominal price of about 10 cents per pound. About 4,000 pounds of "Pinattu" would be required per day to operate a plant producing 1,000 lb. of food yeast per day. "Pinattu" can be produced in large quantities in the Jaffna District during the palmyra fruit season in the dry months of July to October. According to the 1946 census, there are as many as 5,120 acres under palmyra in the Jaffna District (5). In this acreage, it can be estimated that there would be nearly 2,500,000 palmyra trees, of which about a million trees would be fruit-bearing trees. Assuming that a fruit-bearing tree can yield as many as 40 fruits on the average per season, as many as 40 million fruits are available per year for the production of "Pinattu" as a cottage industry. If only quarter of this number of fruits is collected, about 1,200,000 lb. of "Pinattu" can be produced per year during the palmyra fruit season. This would ensure a supply of about 4,000 lb. of "Pinattu" for use per day to work a plant producing 1,000 pounds of food yeast per day for 300 days per year.

Considering the above factors, it appears to be quite feasible that food yeast can be manufactured on a large scale in Ceylon. Two factories, one in the copra area and one in the palmyra area, would produce in all about 300 tons of food yeast per year. This quantity of yeast can be easily consumed by the local population on the basis of the requirements to overcome malnutrition, as mentioned earlier in this article.

The cost of production has been worked out as about 1 shilling for a pound of food yeast in Jamaica, while it has been worked out as only 6 annas per pound in India, where food yeast can be produced from cheap molasses which is a by-product of the sugar industry.

In Ceylon, owing to high labour costs, it may not be possible to manufacture food yeast at such low costs of production. However, judging from the figures quoted from Jamaica and India, and even at a price of 2 cents per gallon of coconut water which is normally thrown away at the copra factories, and 10 cents per pound of "Pinattu", it can safely be assessed that the cost of production of food yeast would not exceed two

rupees per pound. If the selling price of the yeast is fixed at three rupees per pound, the cost of a daily dose of quarter ounce of food yeast per person, on the average, would not exceed 5 cents.

Acknowledgments

I am grateful to the former Director of Agriculture, Mr. L. J. de S. Seneviratne, and the present Director, Dr. A. W. R. Joachim, for the encouragement given to conduct these investigations. I am thankful to Dr. J. W. L. Peiris, the Plant Pathologist, and Mr. L. S. Bertus, the one-time Assistant Plant Pathologist, for maintaining and supplying the cultures of Torula yeast.

References

(1) Food Yeast—A survey of its nutritional value—*British Medical Research Council—Report.* Published by H.M.S O. 1945.
(2) *Food Journal,* 1945, Vol. XIV, p. 116.
(3) *Food Manufacture,* 1947, Vol. XXII, p. 28.
(4) *Industrial and Engineering Chemistry,* 1948, Vol. XL, p. 1,220.
(5) *Gazette Extraordinary,* Ceylon No. 9,596, 1946.

A Modified 'Deep Litter' System for Poultry

J. S. L. WHITE

Received 16.6.55.

THE STRICT deep litter system of rearing poultry is an intensive system in which birds are continually confined to a well ventilated house, the floor of which is built up to about one foot with an absorbent material such as paddy chaff, saw dust, chopped straw or a mixture of these. This litter is stirred frequently and not removed for about one year. The house is a self contained unit, the birds being provided with all their needs—food, water, laying nests and perches. In this system nutrition is very important and rations have to be perfectly balanced to ensure that the birds receive all their protein, carbohydrate, vitamin and mineral requirements. In countries with severe winters this system is ideal as there is no other alternative but to keep birds indoors, while in tropical countries it is becoming popular especially where land is limited. In Ceylon until very recently this system was not adopted at all. Just a few poultrymen are now trying it with success.

It is a generally accepted principle that the deep litter cannot be worked successfully, unless the birds are confined to the house all the year round. This article gives details of a study carried out by the writer at St. Anthony's College, Kandy, where birds were housed on deep litter and also allowed the advantage of natural pasture.

Particulars of Housing

The house, internal dimensions of which were 17 ft. long and 12½ ft. broad, consisted of a floor paved with bricks, roughly cemented and a wall three feet high and four and half inches wide, on the sides and behind. In front, the wall was only 1 ft. high and above it were three separate entrances to the house, the doors of which were made of half inch wire-netting. The space on the sides, between the walls and roof was

Front view of Deep Litter House

also covered with half inch wire-netting. The roof was a 'lean-to' made of galvanized iron sheeting with a hood in front to keep off driving rain. Ample shade was provided by a large tree close

to the house. The house was a self-contained unit with movable perches, tunnel-type community laying nests, metal feed troughs and waterers. The essential features of the house were proper ventilation and freedom from dampness. Each of the three runs adjoining this building was about 1/24th acre in extent, the total area of runs being about 1/8th acre.

Side view of House showing Tunnel-type nesting box

Stock

Two hundred Australorp chicks, one day old, were obtained from the Government Farm, Ambepussa on the 24th November, 1953, and reared on wire-netting-floor brooders, up to the end of two months. At the end of this period they were transferred to natural pasture consisting predominantly of *Axonopus compressus* approximately 1/8th acre in extent. They were housed at night in slatted-bottom range shelters. 168 chickens survived at this stage ; the majority of deaths was due to cannibalism and overcrowding as a result of the runs not being ready to transfer them to the range earlier. There were no deaths subsequently. On the thirtieth of April, 1954, at the age of five months approximately, there were seventy five pullets of which seventy one were transferred to the deep litter house.

Litter Management

Before introducing the birds, about 10 lb. of lime were sprinkled on the floor and over this was spread a four inch layer of paddy chaff. This litter was lightly stirred every day and thoroughly stirred and turned over once a week. It was built up to a depth of 10 in. by addition of about 1½ in. fresh paddy chaff once a month up to the end of four months. Thereafter, no more paddy chaff was added. Air-slaked lime was sprinkled once in two months after the sixth month at the rate of about 1 lb. for every 20 sq. ft. and mixed with the litter. The litter remained in very good condition up to the end of one year, free from dampness and bad odours.

Something noteworthy was the fact that hardly any flies were present at any time. The litter was completely removed at the end of April, 1955, exactly one year after it was first put in and fresh litter was introduced.

Feeding and Management of Flock

Chicks were given broken grain only on the first two days after hatching out. After that dry mash was supplied *ad libitum* (1). Tender grass was made available after the second week, and so was Cod Liver Oil mixed with the mash at one teaspoonful per two pounds mash. No other supplements or antibiotics were given. After the second month the Cod Liver Oil was given only three times a week and after four and half

months only twice a week. Ample water was available at all times. Vaccination against 'Fowl Pox' was done at ten days of age and innoculation against Ranikhet at three and half months. The sexes were separated at three months. Phenothiazin in the form of 'Phenovis' was administered according to directions, mixed with the mesh, at four months of age, again on the twenty seventh April, 1955, just before putting the birds into the deep litter house, and thereafter once a month.

On the thirtieth April, 1954 there were seventy five pullets in all, of which four were culled and seventy one introduced to the deep litter house. The floor space per bird was 3 sq. ft.

Dry mash and water were kept in the house and were available to the birds at all times. Shell grit was provided in a separate container. The birds had access to the pasture in the runs from 9 a.m. to 5 p.m. every day except on very wet days when they were confined to the house. Each run was used for one month at a time and regularly rotated. The pasture looked better at the end of one year than at the beginning except for a bare patch near each entrance to the house, due to excessive trampling and grazing.

The following mash mixtures were used for chicks and growers respectively :—

Ingredients	*0–8 weeks (chicks)*	*9 weeks to 4¼ months (growers)*
Maize meal ..	50%	44%
Coconut poonac (" Expeller ")	6%	15%
Fish Meal ..	22%	18%
Rice bran (Grade I)	20%	20%
Skim milk powder	2%	1%
Sterilized bone meal	—	1½%
Salt ..	—	½%

The mash mixture for pullets older than 4½ months and hens is given below. It will be noted that 'Morlac' coconut poonac which contains only two per cent. fat was substituted for expeller coconut poonac. The former was not available earlier. No whole grain of any kind was given.

Maize meal ..	38%
Coconut poonac " Morlac "	30%
Fish Meal ..	8%
Rice bran (Grade I) ..	20%
Sterilized bone meal ..	1½%
Oyster shell (ground) ..	2%
Salt ..	½%

The birds were in perfect health throughout and did not show even the semblance of a cold or any other ailment. The precaution of dusting the laying nests and litter lightly with Gamexane powder once a month was taken. External parasites such as lice were absent. There was no cannibalism or egg eating. The quality of eggs both external and internal was very good. Broody hens were promptly dealt with by removing them to an adjoining run

Flock at the end of the first year, showing rich pasture and broody house in the background

with a separate night house and supplying them ample food and water. Most of these hens came back into production in three or four days after this treatment.

Six cockerels from the same batch as the pullets, were introduced to the house at the end of June, 1954, and a week later hatching commenced. Fertility and hatchability were good. Results of the first three hatches are shown in the following table :—

Eggs Set	*Date*	*Infertile*	*Hatched out*
50	3. 7.54	9	32
55	28. 7.54	4	44
56	9. 9.54	3	44

On the 14th August, 1954 six backward pullets were culled. On the 18th August another pullet was culled because of an injury. On the 8th December, 1954, three more pullets were killed by pole-cat. Sixty-one pullets were left.

Egg Production

The following are monthly egg production figures :—

Month	*No. of Pullets*	*No. of Eggs*
1954 :		
May	71	444
June	71	1346
July	71	1,333
August	65	1,146
September	64	1,089
October	64	1,087
November	64	1,071
December	61	964
1955 :		
January	61	1,010
February	61	822
March	61	1,035
April	61	971
May (up to 24th)	61	507
	Total	12,825

On the 24th May, 1954, when the birds were six months old, 24 eggs were laid while one week later on the first of June there were 40 eggs. There was no appreciable difference in egg production during any of the months except of course in May, 1954, when the pullets had just come into production and in May, 1955 when they were moulting. First signs of the moulting of the primaries were observed after eleven months of continuous production. Every bird was handled at the end of the period under review. All were in very good condition except seven that showed signs of putting on fat and four that were underweight. Handling revealed that the majority of the birds had commenced moulting their primaries, some were about half way through their moult, while a few had not commenced at all.

The average egg production per bird was as follows :—

(*a*) 171 eggs—based on the unculled population of 75 pullets originally in the flock.

(*b*) 180 eggs—based on the 71 pullets housed.

(c) 197 eggs—based on the average number of pullets, during the year, i.e., 65.

Such a high average for a flock of this size has not been recorded before in Ceylon and shows what results can be achieved with proper feeding and management of the stock presently in this country.

Acknowledgment

My sincere thanks are due to the Principal of St. Anthony's College, Kandy, who so willingly constructed the buildings and gave me all the co-operation and assistance to make this study possible.

Reference

(1) WHITE, J. S. L. (1954). "A feeding trial with chickens under backyard conditions", *Tropical Agriculturist, Vol. CXI. 1955.*

Rice in California

M. F. CHANDRARATNA

In October, 1954, the generosity of the Asia Foundation made it possible for me to visit rice research centres and production areas in the U. S. A. The following account of California's rice industry, and of the contribution made to it by the rice breeders and agronomists in that state is the outcome of that tour.

California and the three southern states, Texas, Louisiana and Arkansas, contribute the bulk of the rice produced in the U. S. A.; acreages and production figures for 1953 are listed below :

States	Paddy Acreage		Paddy Production	
	Acres	Per Cent.	Centals	Per Cent.
California	394,207	18·4	12,154,547	22·8
Texas	573,385	26·8	14,666,571	27·5
Louisiana	604,505	28·3	12,220,387	22·9
Arkansas	485,152	22·7	12,311,378	23·1
Total for the U. S. A.	2,139,274	100·0	53,328,125	100·0

California's rice acreage in 1954 approximated 450,000. Of the major rice-producing states, California's industry is the youngest. When yields of wheat and barley on the heavy adobe clays of the Sacramento and San Joaquin Valleys commenced declining rapidly, farmers turned to rice. In 1908, for the first time in California, an experimental area of 40 acres near Biggs was planted in Japanese varieties. Commercial production commenced after the establishment in 1912 of the Biggs Rice Experiment Station, on land and finances provided by the Sacramento Valley Grain Association. Sacramento and San Joaquin soils appeared eminently suitable for rice. The heavy clays permitted the maturing of a rice crop with four acre-feet of irrigation water. These soils crusted and cracked when drained before harvesting, and were capable of carrying combines. Moreover, temperatures were sufficiently high, although occasionally cold water damage was recorded.

Biggs Rice Experiment Station

The Biggs Station, which bred the varieties and perfected the cultural practices in use in the state, may be said to have parturated California's rice industry. The station, whose initial extent of 56 acres has expanded to 127, has been particularly fortunate in its succession of Superintendents: Mr. E. L. Adams (1912-18), Mr. Jenkin W. Jones (1918-31), Mr. Loren L. Davis (1931-47), Mr. A. H. Williams (1947-53)

and Mr. Dwight C. Finfrock (1954-). These eminent men made California's thriving rice industry possible.

The Sacramento Valley Grain Association, under whose auspices the station was opened, has been reconstituted under the name California Rice Research Foundation Inc. This foundation contributes 25 cents per bag of paddy milled to a fund devoted to rice research. The expansion of both the staff and scope of the Biggs Station has accordingly become possible. Dr. J. R. Thysell who has had extensive experience of rice in Thailand is a recent recruit to Biggs and heads the breeding section. The station maintains close liaison with research workers in the University of California. Dr. D. S. Mikkelsen of the University directs the fertilizer investigations at Biggs.

Varieties

California's rice industry is based on varieties bred at Biggs. The short-grain "pearl" varieties of California possess a large proportion of *japonica* blood. From the commencement of commercial cultivation in 1912 till about 1921, when breeders at Biggs released Caloro, varieties native to Japan, like Watari-bune and Shinriki, were grown. Caloro is a bold-grained, short-awned, widely adaptable, high-yielding, photoperiod-sensitive variety that can mature in 150 days. The grain shows "abdominal white", and does not mill too well. Nevertheless, Caloro commands the greatest popularity in California.

Colusa 1,600, which was released in 1917, never covered more than a fraction of the acreage under Caloro. It is also bold-grained, but possesses higher fertilizer response and less sensitivity to the photoperiod. It is, moreover, about 15 days earlier. The sterility caused by low temperatures at pollination is particularly high in Colusa.

Cody, which derives from the cross Colusa × Lady Wright, is stiff-strawed, but has never been extensively grown.

The desire to produce a fine-grained rice has dominated breeding programmes in California for many years. The antecedents of the medium-grained selections Calady 40 and Calrose are indicated below :

CALORO × LADY WRIGHT
(*Short-grain*) (*Long-grain*)

CALORO × CALADY 40
(*Medium-grain*)

CALROSE
(*Medium-grain*)

Calady 40 and Calrose were released in 1940 and 1947 respectively. Although Calady 40 mills well, it has not found favour with farmers. It is about a week later than Caloro, and, on account of its lush growth, does not combine well. Calrose is as early and as high-yielding as Caloro, but has a longer grain and better milling performance. In 1953, Calrose covered 4.5 per cent. of California's rice acreage. In view of the known antecedents of all these selections, one would expect them to possess high tillering capacity. Under the conditions of dense seeding that obtain in California, however, tillering is surprisingly sparse.

Dr. Thysell has an extensive range of introductions from Japan, Korea, Italy and Iran under test at Biggs. Selections

for earliness, grain length and straw strength will be used for grading up Caloro and Calrose.

Rotations

Nearly three-fourths of California's rice acreage follows the "idle fallow" system under which rice alternates annually with a weed fallow. The rest of the rice acreage is either cropped continuously in rice or carries rotations with a variety of crops. The number of crops that thrive on the heavy clays that compose most of California's rice soils is not large. The lighter soils are more versatile and carry a greater diversity of crops. Wheat, barley, beans, safflower and sugar beets rotate with rice in California. These crops are rarely as profitable as rice.

Tillage

The heavy adobe clays are difficult to work. The land is spring-ploughed to a depth of 4-6 inches. The lighter soils are often disced except where continuous cropping or the "idle fallow" system prevails. Preparation is completed by harrowing and dragging. Too fine a seedbed promotes the drift of rice seed and the growth of weed, and is accordingly avoided. Dikers reconstruct levees in each season.

Seeding

Seed soaked for two days is broadcast by airplane at the rate of 150 lb. per acre direct on the water, immediately after flooding of the fields. A long interval between flooding and seeding allows time for weed and algal growth, and aggravates anaerobic conditions with consequent damage to germination. The practice of seeding into standing water contributes to weed control, and if fungus and bacterial damage to germinating seed is not excessive under the high temperatures that obtain in Ceylon, the practice may have value in the rain-fed areas in this country.

Fertilizer Practice

It is only to nitrogen that California's rice soils show striking response. The application of phosphate and potash usually gives no apparent benefit. Trials at Biggs indicate that the optimum dose of nitrogen is about 40 lb. per acre. Maximum yields are obtained at about 60 lb. N per acre. Heavy applications of nitrogen may force flowering into periods of falling temperature, and cause high sterility.

The nitrogen fertilizers in general use are ammonium sulphate, urea and calcium cyanamide. At the same nitrogen content, these fertilizers appear to be equipotent. Ammonium sulphate is often top-dressed by airplane within two months of seeding. Nitrogen placement has been the subject of investigation by Dr. D. S. Mikklesen at Biggs. Fertilizer drilled four inches deep has given yield increases of 36 per cent. as against increases of 11 per cent. with broadcast fertilizer.

The use of anhydrous ammonia is being explored at Biggs in collaboration with the Shell Chemical Co. The practice of injecting ammonia into the soil has given strikingly high yields, and is extending steadily.

Weeds

Since its introduction in 1946, the use of the weedicide, 2, 4-D has spread steadily and now extends to over half

of California's rice area. The possibility of serious damage to adjacent cotton crops excludes the use of 2, 4-D from the rice tracts in the San Joaquin Valley 2, 4-D is generally satisfactory but the prevalence of high temperatures at or after spraying, and the use of high concentrations cause considerable damage even to rice. A spray strength of 18-24 oz. per acre is recommended. Studies at Biggs indicate that the optimum spraying time is about 50 days after seeding. Very early and very late sprayings depress rice yields.

In recent tests, 2, 4, 5-T has proved less injurious to rice, but is also less effective weedicidally than 2, 4-D. MCP is almost as innocuous to rice as 2, 4, 5-T, and is as potent a weedicide as 2, 4-D. Its high cost, however, prevents its general use.

Unfortunately, the ubiquitous watergrass (*Echinochloa* spp.) resists both 2, 4-D and MCP. Submergence for about three weeks is necessary for the control of watergrass. Water plantain (*Alisma plantago*), redstem (*Ammannia coccinea*), bulrush (*Scirpus fluviatilis* and *S. mucronatus*) and burhead (*Echinodorus cordifolius*) succumb readily to 2, 4-D.

Rice farmers agree that their most obnoxious weed is red rice. One red grain in 200 places the grade of rice below No. 1. Farmers fight this menace by using clean seed and avoiding infested fields.

Crop Hazards

The rice crops that I saw in Sacramento number among the cleanest I have seen in any part of the world. The diseases and pests that ravage rice in most countries are conspicuously scarce in California. About the only grave hazard to Californian rice is cold-water damage. Fields irrigated from main channels may suffer severe injury in the area surrounding the point of water intake. Affected portions amounting to 20 per cent. of a field may be left unharvested. Research in California indicates that water temperatures below 70°F. damage the rice crop. Methods of minimizing cold-water injury include the use of prewarming basins and reduction in the intake of irrigation water.

The Cultivation and Curing of Cigar Wrapper Tobacco

S. V. MANUEL PILLAI

THE CIGAR consists of three portions of tobacco leaf: the filler, the binder, and the wrapper, in the proportion of about 85, 10 and 5 respectively. Countries which produce high quality cigars use tobacco leaves of different types for the filler, binder, and the wrapper; each having its own particular qualities contributed by inherent and environmental factors. Of these the wrapper is the most important, as the finish, appearance and, to a certain extent, the burning quality depend on it. The leaves of certain varieties of *Nicotiana tabacum* only can be used as wrappers. Sumatra produces the world's best wrapper tobacco, where it is cultivated under the natural conditions prevailing there. Experiments conducted in Florida from 1900 indicated that thin wrapper tobacco, comparable with what is imported from Sumatra, could be produced by growing tobacco under artificial shade. The area under wrapper tobacco consequently has steadily increased to about 15,000 acres at present. Production of this type of tobacco requires a large amount of capital investment to provide shade over the entire field. Shade reduces sunlight and makes it possible to grow thin leaves of fine silky texture.

The general methods adopted in regard to the care and maintenance of nursery and preparatory tillage of the field are the same as for cigar and cheroot tobacco. Light sandy soils, sandy loams and alluvial soils are suitable. Slightly acid or neutral soils favour the production of good quality tobacco. Seedlings are transplanted eighteen inches in rows which are spaced two feet apart. Weeding and intercultivation are carried out in the usual way.

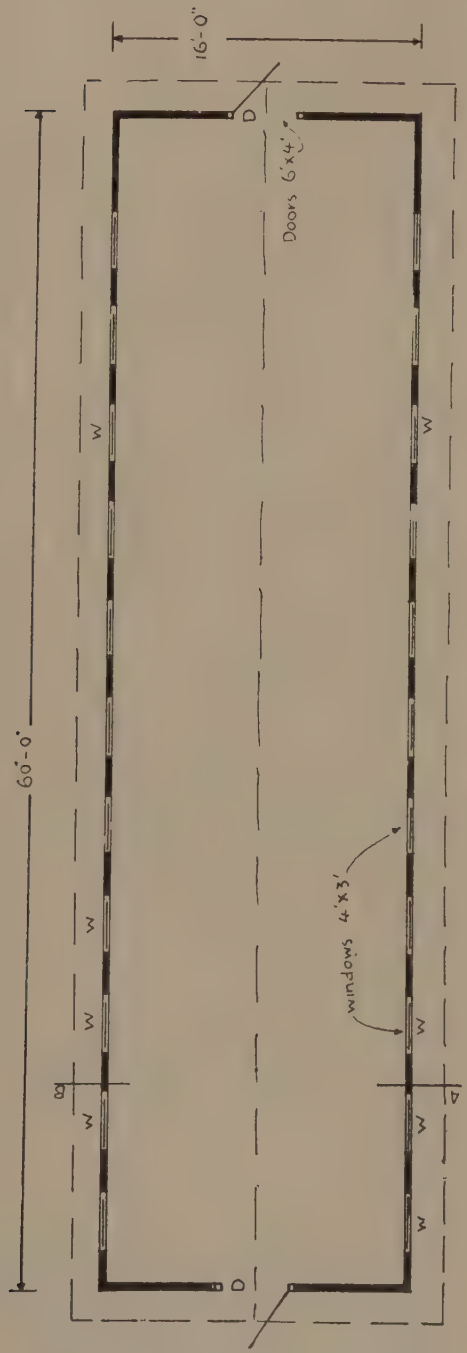
After-care of Crop

Wrapper tobacco is not topped as the object is to get thin leaves. The plants should be supported with bamboo chips or thin twigs of trees to prevent lodging and consequent damage. Irrigation should be quite frequent so as to maintain humid and warm conditions.

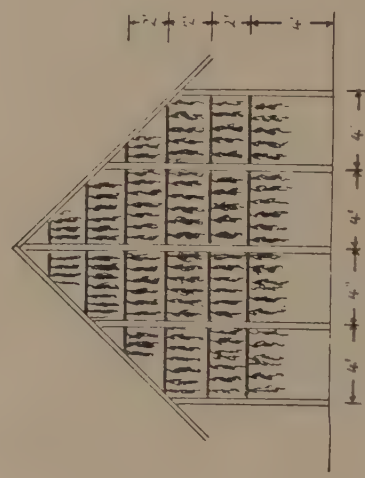
Harvesting commences from about two months from the date of planting. The leaves are harvested from the bottom upwards, removing two to three leaves at a time, depending on maturity as indicated by the light green colour and incipient yellowing along the margin. Harvesting is done in the evening and the leaves are allowed to wilt at night. Scissors should be used for harvesting to avoid damage to leaves. The harvested leaves should be collected the next morning in flat baskets, lined with moist hessian cloth and removed to the curing room.

Curing

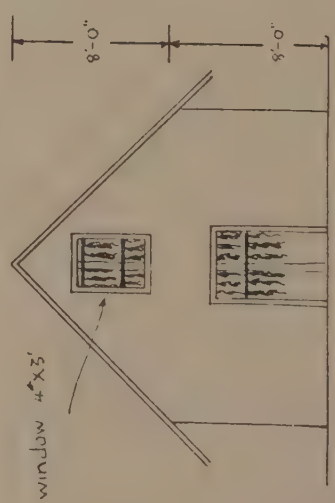
A well constructed room with windows and ventilators to regulate the temperature and humidity is necessary. Wooden tiers 2 feet vertically and 4 feet horizontally are constructed as in the case of a flue curing barn.



GROUND PLAN



SECTION A-B



FRONT ELEVATION

PLAN OF A CURING BARN

Wrapper tobacco leaves are strung in pairs, with backs touching each other, through a three-pliered jute thread, passing the threaded needle through the midrib of the leaves about one inch from the base. About 30 leaves are strung on a string four feet long. The free ends of the string are tied to a stick about 4½ feet in length and 1½ inches in diameter. A dry and wet bulb thermometer is fixed in the centre of the curing room. The ventilators are adjusted in such a way that the difference between the dry and the wet bulb thermometers is 5°F. to 7°F. in the early stage and about 7°F. to 10°F. in the latter stage of curing. If the difference is less, the ventilators may be opened, and closed if more. If necessary water may be sprinkled on the floor of the room. Curing is completed in two to three weeks after stringing. Leaves wilt, turn yellow first and finally to light brown and the midrib starts drying. Soon after the midribs become completely dry, the leaves are removed when they are in a pliable condition and tied in bundles. Properly matured leaves cure to a light brown colour with good shine ; immature ones to a dull colour and over-mature leaves (i.e., when the yellowing is pronounced) cure to a dark brown colour.

The tobacco is fermented in rectangular bulks, and the bulks are turned over till the temperature is about 115°F. to 120°F. Three to five turnings are necessary. During fermentation and storage for about a year, the leaf burn improves and the aroma is refined due to loss of nitrogenous compounds. The burning quality is governed, however, by the ratio of potassium to chlorine originally present in the leaf. The loss of chlorine is very negligible in storage. Fermentation tends to distribute the leaf-burn more uniformly over the entire leaf. The proper humidity should be maintained during storage. The leaves must be stacked in a raised wooden platform four inches from ground level. This facilitates aeration. Water may be sprinkled if necessary in the room. Finally the tobacco is graded according to colour, size and soundness of leaves. The colour desired is lustrous light brown. Good wrapper tobacco should have thin veins, be uniform in colour, silky in texture, elastic, and of low ignition point.

For good burning the potash content must not be less than 2.5 per cent., chlorine not more than 0.4 per cent. and nitrogen less than 4 per cent. Potash promotes softness in the cured leaves by encouraging the absorption of moisture and this facilitates handling. The fire-holding capacity is dependent on the potassium salts ; but an excess makes the ash dark in colour.

Quality in tobacco is a complex factor and varies according to the likes and dislikes of individuals. Quality is judged in smoking. If the smoke is alkaline it irritates the throat. As the nitrogen content increases the alkalinity of the smoke also increases. An acid smoke is what is required and a high sugar content is conducive to an acid smoke. About 160 leaves make up one pound and are sufficient to make 1,000 five-inch long cigars.

Reference

Annual Report on Tobacco Statistics, U. S. D. A.

DEPARTMENTAL NOTES

Rehabilitation of the Citronella Oil Industry in Ceylon

(*Extract from the Report of the Inter-Departmental Committee*)

SUMMARY AND RECOMMENDATIONS

1. EXPERIMENTS conducted by the Department of Agriculture have revealed that manuring is very effective in increasing the yield of oil per acre of citronella grass. The increase in yield of oil under experimental conditions from manured plots has been found to be three to four times that from unmanured plots. The extra cost of manuring as recommended by the Department would be more than compensated for by the resulting increase in oil.

2. The Department of Agriculture should conduct experiments in a typical citronella area to test out strains of *lenabatu* from plantations reputed to give high yields. Simultaneously the Department should conduct experiments with imported strains of *maha pangiri* from Java in order to select the best under local conditions.

3. Fertilizer trials should be undertaken on old citronella plantations.

4. Investigations conducted by the Department of Industries have shown that the distillation efficiency could be very appreciably increased by the adoption of simple technique without extra expenditure.

It is recommended that—

(*a*) 10-12 lb. of loosely packed grass per cubic foot of still is used.
(*b*) Distillation be limited to three hours.
(*c*) The boiler be fired at regular intervals of ten minutes to maintain a steady steam pressure.

5. A system of certification for Estate Quality and F. A. Q. Oils before export should be introduced.

6. The administration of the scheme should be entrusted to the Department of Commerce.

CENTRAL BOARD OF AGRICULTURE

PROCEEDINGS OF THE NINTH MEETING OF THE CENTRAL BOARD OF AGRICULTURE HELD AT THE SCHOOL OF AGRICULTURE, PERADENIYA, ON MAY 2, 1955, AT 2.30 P.M.

Dr. A. W. R. Joachim, Director of Agriculture, presided, and the following were present :—Mr. C. A. M. de Silva, Vice-Chairman ; Mr. S. H. Mahadiulwewa, M.P. ; Mr. A. G. Divitotawela ; Gate Mudaliyar N. Wickremaratne ; Mr. T. B. Naranpanawa ; Mr. A. D. Paranavitana ; Sir James P. Obeysekera ; Mr. J. V. Fonseka, Director, Land Development ; Mr. L. B. Rajakaruna, representing the Commissioner for Development of Marketing ; Mr. D. B. Ellepola ; Mr. A. E. C. de S. Gunasekera ; Mr. Ray Wijewardena ; Mr. C. J. Strachan ; Mr. M. B. Samarakoon ; Mr. S. Vythilingam, M.P. ; Mr. S. Thondaman ; Mr. A. M. Clement Dias ; Mudaliyar N. M. Abul Cassim Marakar ; Mr. N. R. Rajavarothiam, M.P. ; Mr. R. T. Chelliah ; Mr. A. Perumynar ; Mr. J. M. Sabaratnam ; Mr. S. Pathmanathan ; Mr. R. H. de Mel ; Mr. S. L. Bandara Dharmakirti ; Mr. G. B. Portsmouth, Acting Director, Tea Research Institute ; Mr. Kenneth Morford ; Mr. M. Atkinson ; Mr. N. H. Keerthiratne, M.P. ; Gate Muhandiram Arthur D. S. Jayasinghe ; H. B. Rambukwella Dissawe, M.P. ; Mr. S. C. Fernando, Commissioner of

Co-operative Development, Registrar of Co-operative Societies, Acting Director of Food Production; Mr. K. W. Devanayagam; Senator Thomas Amarasuriya, O.B.E.; and Mr. N. P. Wijeyeratne, C.C.S., Secretary.

The following visitors were present by invitation:—

Mr. T. M. Z. Mahamooth, Deputy Director, Animal Husbandry; Mr. J. C. Drieberg; Mr. A. V. Anker, General Manager of Animal Husbandry Farms; Dr. P. Mahadevan, Veterinary Research Officer; Mr. W. D. E. Perera, Livestock Officer; Dr. F. N. Ponnamperuma, Chemist, Department of Agriculture.

Letters and telegrams regretting inability to attend were received from the following:—

Mr. T. C. Rajaratnam, C.B.E., J.P., U.M.; Mr. W. M. Cumaraswamy; Mr. S. A. Selvanayagam, O.B.E.; Mr. K. Kanagaratnam; Major E. C. de Fonseka, M.B.E.; Mudaliyar M. M. Ebrahim; Mr. C. Wijesinghe; Sir Wilfred de Soysa; Senator (Mrs.) Clodagh Jayasuriya; Director of Rural Development; Mr. S. Sivapalan; Mr. Vernon Rajapakse; Senator Justin Kotalawala; Mudaliyar S. Armstrong; Mr. R. H. Spencer Schrader; Mr. S. Pararajasingham, J.P.; Dissawa S. A. I. Elapata, M.B.E.; Mr. A. C. Ponnampalam; Mr. H. A. Pieris; Mr. Gladwin Kotalawala, M.B.E., M.P.; Senator (Lady) Molamure; Mr. Marcus S. Rockwood; Mr. S. M. Rasamanickam, M.P.; Director, Coconut Research Institute; Senator E. W. Kannangara, C.B.E.; Mr. U. B. Dedigama; Gate Mudaliyar M. S. Kariapper.

I—Confirmation of the Minutes of the last Meeting

The minutes of the previous meeting of the Central Board of Agriculture were unanimously confirmed.

II—Matters arising from the Minutes

Chairman—"Gentlemen, I have to refer at this meeting to the action taken in regard to the resolution moved at an earlier meeting by Mr. Kenneth Morford. The practice is for us to have minutes confirmed and thereafter to take action in regard to any items or motions which have been passed. Mr. Kenneth Morford at the meeting previous to the last one, moved a resolution in regard to the provision of Mobile Veterinary Dispensaries so that veterinary aid may readily be available in rural areas by arranging scheduled visits. We have written to the Permanent Secretary and asked for permission to include provision for these vans in our estimates for 1955-56. This was obtained. The matter has since gone up to the Treasury for final consideration and the Treasury has approved one mobile Veterinary Dispensary for a start. In addition to taking that step, we have also asked the Colombo Plan authorities whether they could come to our aid in this matter and very recently we had a visit from the Canadian authorities. We put before them this proposal and this item has been included in their proposals for aid. Therefore the chances are that it may be possible to get three of these units from Canada in the course of next year.

In the discussion on this resolution reference was also made to the employment of more Veterinary Officers in the interests of Animal Husbandry development in the country. This suggestion too has received the favourable consideration of the Ministry and the Minister himself directed that provision be made for a number of veterinary posts. These were duly included in the estimates and I am glad to say that the Treasury has approved eight new posts of Assistant Veterinary Surgeon. These are the only matters I have to bring to your notice regarding the meeting previous to the last.

At the last meeting a number of resolutions were passed, and now that the minutes are confirmed, I propose to take action on them in the next few weeks. Although, in some instances, some members may wish us to proceed with action on resolutions, &c., before the minutes are confirmed, you will I think agree that action on matters discussed could be taken only after the minutes have been confirmed."

Members were in agreement with this view.

III—Election of a Member to serve in the Minor Products Sub-Committee of the Central Board of Agriculture

Chairman—" Gentlemen, you will remember that we have now three Sub-Committees of this Board, one for Paddy Cultivation, one for Animal Husbandry and one for Minor Products. These Sub-Committees have met and have drawn up a programme of their activities. Mr. Hensman has written to us that he is unable to serve on the sub-committee for Minor Products. In the circumstances, the Sub-Committee have co-opted a very useful member, Mr. D. B. Ellepola, and I am sure you will all agree with that selection."

This was agreed to.

IV—Resolution to be moved by Mr. R. H. Spencer Schrader

" Having regard to the impetus given to animal husbandry on estates by—

(1) The Food Production Department by allowing liberal rates of exemption under the regulations in the case of dairy type cattle ;

(2) The Milk Board establishing milk collecting centres in estate areas.

The Central Board of Agriculture recommends to Government :

(*a*) That immediate steps be taken to inaugurate an intensive propaganda campaign in the coconut producing and other suitable areas in the Low-country for the proper management and adequate feeding of Sinhala type of cattle with a view to obtaining milk from a new source ;

(*b*) That an Advisory Branch of the Agricultural Services be established to establish to help cattle owners all over the country and in the coconut growing areas in particular with advice on the cultivation of pasture, ensilage of suitable crops, and hay making ;

(*c*) That the Advisory Branch of the Veterinary Service be re-organised so as adequately to help cattle owners all over the country with advice on the health, the proper management, and care of their animals.

The Chairman read out a telegram from Mr. Spencer Schrader regarding his inability to attend the meeting owing to some unavoidable circumstances and suggested that the resolution be deferred for the next meeting. This was agreed to by the Board.

V—Consideration of the Paddy Sub-Committee's Report on the Report of the Joint U. K. and Australian Mission on Rice Production in Ceylon—1954 (Sessional Paper II of 1954)

Chairman—" Gentlemen, here again I have to say that this Sub-Committee is not in a position to submit their views on this report. Dr. Chandraratne who is the Convenor of this Sub-Committee is not here but he has advised the Secretary to this effect. We have one or two members of this Sub-Committee present here today and Mudaliyar Wickremaratne is one. Unless they like to say something about the present position, we will perhaps have to await their report."

Gate Mudaliyar N. Wickremaratne—" Gentlemen, with regard to the Paddy Sub-Committee I would like to say that we met on three occasions during the last several months and that the attendance has not been very satisfactory, perhaps because they have more important business to attend to, but at the same time there are areas where activities of the present food production work are going on. I would, however, like to add another name to the Sub-Committee and I asked the Sub-Committee whether there is any objection to their including another name. They told me that they had no objection but the name proposed should come through the Board. Anybody travelling by train from Kandy to Colombo or from Colombo to Kandy will see a vast difference in the paddy fields along the railway route compared to other paddy areas. When Mr. Rhind was Director of Agriculture, I submitted a memo asking him to take some interest in those paddy lands between Polgahawela and Kandy which were not cultivated both seasons, *yala* and *maha*. I think there was a report from one of the Divisional Officers to say that it cannot be done because the cultivators do not want it and that they wanted only one crop. I replied that I was very sorry and

that it gave me much pain of mind to see those lands not being cultivated during *yala*. An officer has even said "ask Mudaliyar not to worry about it". Now I have seen, Sir, when I visited Kandy during last month and this month, paddy cultivation in these areas being done during *yala*. Near Mirigama I found all the land prepared and ready for cultivation. Therefore, I think we must get somebody from that area for the Paddy Sub-Committee and I would like to suggest the name of Sir James P. Obeysekera."

Mr. A. Perumynar seconded this proposal which was unanimously carried.

VI—Resolutions to be moved by Gate Mudaliyar N. Wickremaratne

(i) "That steps should be taken to meet the serious shortage of farm hands and plough cattle in the cultivation of paddy in the country by recruiting young men and women of the ages 16 to 24, who had received some education, for seasonal cultivation in the first instance and by making facilities for them to be absorbed into farm life and also by increasing the availability of plough and draught cattle to farmers;

(ii) Owing to the serious shortage of uncultivated land in the wet zones of the Island to meet the requirements of the growing population that no more lands should be allowed for growing rubber or tea;

(iii) That the rice milling industry is a necessary adjunct to the development of paddy cultivation. There should be a better understanding and relationship between the paddy cultivator, the mill owner and the authorities of the departments concerned for their mutual economic benefit."

Gate Mudaliyar Wickremaratne—"Mr. Chairman and Gentlemen, I have sent this motion for discussion in order to obtain the views of the members of this House and it is not one which I want to be proposed and seconded. What I want is the opinion of the House expressed on this motion. Even now I travel at least three times a year in the Southern Province, North-Western Province, North-Central Province, &c., and during my visits I have seen only old people engaged in work on paddy cultivation. What will happen when these old people cease to exist? Can the younger generation handle the situation? I know that recently some youth clubs have been organized but what I feel is that that kind of voluntary organization will take years and years to supply the necessary help to the cultivator. First of all, the younger generation must learn to acquaint themselves with the routine of the paddy crop. The work of the paddy farmer at this state will receive a serious setback and that is why I bring up this motion. When I was a boy, paddy cultivation was considered another cottage craft and the father, mother, brothers and sisters all took to it as their daily routine. When I was a boy of 16 or 17, I never failed to take part in these paddy cultivation operations. When I came to Peradeniya to learn practical agriculture, I saw the paddy fields full of people, men, women and children. They all worked together in the field and the result was that yields were very much better than now. The labour was not paid for but the owner of the field who received the labour was obliged to offer the services of himself and his family when those who helped him were doing their cultivation operations. There was a great deal of family co-operation among villagers during that time and the Sinhalese term for this kind of labour is "Attam". Those who were unable to offer their services were in the habit of giving other help in the form of cattle, ploughs, &c. Now this custom is fast disappearing in the villages and as a result yields are declining and the villager does not get a proper return for his labours. One of the reasons for this state of affairs is the wrong education imparted to them in cultivation methods. Now what has happened in the villages is that the father and mother have to work hard in the field and the children are sent to school and these children do not even see the colour of their fields. Especially those children who learn English in school feel ashamed of themselves to assist their parents in the field. Some children feel ashamed even to help the

mother in cooking. This is why we see in the press that thousands of young men who have passed the S. S. C. are waiting for jobs. What is the purpose of their education, is it to find jobs? What I feel is that in their education, they must be taught how to work a paddy field and other agricultural operations. Another thing I notice is that 30 to 40 years ago each village home had a vegetable garden but today that habit has also faded away. In the olden days the village blacksmith turned out the mamoties that were required by the villagers for their paddy cultivation. Today the village blacksmith has disappeared and the mamoties used by the cultivators are imported ones which are not suited for our conditions.

Therefore, my suggestion, gentlemen, is that Government should recruit the services of these young men and women in the villages during seasonal cultivation to help the cultivators in their cultivation operations. Women can help in work like transplanting and weeding and men and boys can help in other cultivation operations. What I suggest is that Government should formulate a scheme for recruitment of the services of these young men and women in the villages and form them into different age groups, so that women can offer their services for transplanting, men can do ploughing and children can give a helping hand in other operations. A list of persons whose services can be recruited for this purpose must be prepared in respect of every village and D. R. O's Division. Then we should organize a scheme of wages for these people so that they would receive them from time to time according to the work they perform. After some time when they are fully competent some of them could be absorbed in their own field of work, and we could send them to colonization schemes like Gal Oya where they could be of great service.

I read in the papers that S. S. C. men should be given land for cultivation but the difficulty is that these S. S. C. men do not know how to handle a mamoty. Some years ago in 1902 when the old Agricultural School was closed, Government started school gardens. There were hundreds of school gardens all over the Island where boys were trained to do mamoty work and grow vegetables. That was stopped by the Education Department and they were made to learn English after which they gave up gardening and vegetable cultivation and now they are ashamed to even associate with their elders in cultivation operations. Now these boys should be taught to associate with their elders in all matters connected with their cultivation and during the off season they should go to the paddy field and see what is happening. The other day I learnt from a Japanese expert that unlike in Ceylon, the cultivator in Japan is always in the field, during the time of ploughing, sowing, weeding, harvesting, &c. Our people, once they sow the paddy, go to the field again only to reap it. The present younger generation can be easily trained by Agricultural Instructors who are stationed all over the country. They must be taught to see how much water there is in the field, whether any pests are attacking the crop or whether any disease is breaking out in the area and they must be asked to collect all the rubbish they throw in manure pits and make use of it as manure during the next season, for their fields.

American, Canadian and Australian Governments are giving us millions of rupees worth of aid for under-developed areas. Why cannot we start operating a scheme of this nature for the under-developed youth of this country? I do not think that we should utilize this money that is coming in the form of aid from foreign sources on all kinds of unnecessary ventures. Our younger generation should be trained to co-operate with their elders in paddy cultivation. I read an article in the press that in Italy when there was a shortage of labour during the time of Mussolini, men and women were brought from outstations for cultivation work and were sent back after the cultivation season was over. The people who worked did not only get a training in cultivation work but they were also remunerated for their services. In the same way our men and women can make their services available in places where they are required for cultivation purposes. Those are my views gentlemen, and I would like the opinion of the Board on this matter.

The next point I want to mention is about cattle. I cannot really understand how paddy cultivation can be done without cattle. In my own village, after 1912 there is no ploughing of paddy fields. We all do our paddy cultivation with the mamoty and those mamoties are turned out by the local blacksmith because imported mamoties are not fit for paddy cultivation. But of course the Governor-General now feels fit to get into the field to do ploughing but I do not know whether anybody else does any ploughing! Any way I was speaking of these mamoties which are used for paddy cultivation. These mamoties differ in shape according to different districts. The mamoty that is used in Jaffna is quite different to that used in Kandy and the Southern Province. We cannot improve paddy cultivation with mamoties unless we have sufficient cattle to do our ploughing. We are all glad to hear that animal husbandry is developing and that good progress has been made. I have to say a word on this since Mr. Schrader has also some resolutions to move on this subject. Countries like Denmark and Australia develop their animal husbandry for the sole purpose of producing butter, milk, &c. But if we in this country attempt that, we will never succeed. Our chief requirement is cattle for ploughing the fields. We cannot do mechanized ploughing in 2/3rds the area of this country. It may be possible in the dry zone but even there I have my objections to it. Is it possible to do mechanized ploughing in the Kandyan areas? Most of our paddy fields are not suitable for any type of mechanized ploughing. Therefore we must have enough buffaloes to continue this essential operation of ploughing, and I suggest that the Department should pay more attention to the country's requirements of cattle and buffaloes.

I do not like to say anything against the Milk Board, but I would like to ask what they are doing. They are collecting milk from Polonnaruwa and other outstations and are feeding the Colombo folks. I therefore want the Department of Agriculture and the Ministry to take steps to pay more attention to the need of providing more agricultural cattle."

Mr. S. Pathmanathan—"Mr. Chairman, does he mean conscription? We do contribute towards free education; does he mean compulsory education or a re-organisation of the education system around areas where we have paddy? Any way I do not know whether boys from Royal and other colleges will come down to rural areas."

Chairman—"Mudaliyar, do you mean conscription?"

Gate Mudaliyar Wickremaratne—"No, Sir, not conscription. That will be the last thing I will think of even if I have to die! What we want is co-operation and the Sinhalese term for this kind of labour is "Attama."

Mr. C. A. M. de Silva—"Does Mudaliyar know that today one cannot sell buffaloes? We find it difficult to dispose of our cattle because there is no buyer. Therefore, most estate owners have given up rearing buffaloes."

Mr. S. L. B. Dharmakirti—"That I think is because your prices are too high."

Mudaliyar Wickremaratne—"Can you name a few estates."

Mr. C. A. M. de Silva—"Palugaswewa Estate is one."

Mr. D. B. Ellepola—"Mudaliyar Wickremaratne has raised a matter of very great importance to the country. In the form which his motion is presented, it is presumed that there is a very serious shortage of personnel for agricultural purposes. It is for us to decide whether that is a correct presumption. My own view is that the Mudaliyar is right. If it is the correct presumption, it is of very serious importance. If a condition of shortage of labour exists in a country which is 85 per cent. rural or largely agricultural, it behoves us to support this proposal as far as possible together with any proposals that we have in mind. I wish to submit that if this position is correct, then the causes are very fundamental. They are perhaps a part of the educational system in the country or of the social attitude of the country in regard to agricultural employment and in that way very large questions are involved. Therefore, if it is the opinion of this Board that there is a growing shortage of hands for agricultural purposes, particularly for peasant agriculture, then I wish to submit that it is incumbent on us who are members of this Board to address our minds seriously to this

matter. It may be even a matter for a Sub-Committee to go into with great thoroughness as to the extent of the shortage, whether it is growing or whether it is declining and what the reasons are for it and what necessary remedial measures should be taken. If the causes are fundamental and the task is for those connected in the fields of employment and social activity, then I think the remedy will also have to be very fundamental. I think it is for us to decide whether there is an incidence of shortage and if so whether we can approach that matter in this way."

Mr. Kenneth Morford—Mr. Chairman and Gentlemen. As you know my area (Kotmale) does not suffer from a shortage of labour. We do our cultivation and harvesting at the correct time, and in the slack season work is generally available on estates. We are hoping to implement a scheme whereby labour from our areas will proceed to the peasant settlements at Galoya, &c., at harvest time to assist at harvest, but they will return to their Kotmale villages when it is completed, thus fulfilling part of the Mudaliyar's proposals.

A Sub-Committee should be appointed to find out the real needs of each Province otherwise these proposals will come to nought.

Mr. Thomas Amarasuriya—"Mudaliyar Wickremaratne's motion is a very important one. He clearly stated that there are a large number of students who had passed the S. S. C. Examination who are practically idling so that it strikes me that the chief intention of the Mudaliyar is that all these educated youth should be made to devote their attention to agricultural activity as there is a great demand for agricultural hands in this country. One member raised the question whether students from Royal and other colleges would be prepared to go to rural areas to learn agriculture. What Mudaliyar feels is that the present day younger generation should be taught the advantages and the necessity of getting back to the land as this is an agricultural country.

In regard to Mudaliyar's suggestion that men and women between the ages of 18 and 24 should be recruited for seasonal cultivation of paddy, there are a large number of schools in the rural areas where village lads are trained in agriculture. I know of one in the Southern Province where youths get some sort of education in agriculture. I would like to know whether it is not possible to see that these youths make use of their training for agricultural purposes. If all these young men in the villages are trained in agriculture in the various agricultural farms and if they can come up to the standards expected by the Department, the Government may be in a position to get these young men to divert their attention towards what Mudaliyar Wickremaratne has in mind. This is a very wide subject that cannot be settled at a meeting of this type. I think a committee should be appointed to report on the position so that necessary action may be taken."

Mr. J. M. Sabaratnam—"Mr. Chairman and Gentlemen. If the idea of this Board is that there is a labour shortage and that this Board should be in favour of a recruiting campaign in order to see that more labourers are recruited for cultivating the lands of wealthy proprietors, then I think that point of view might be accepted; but if the aim of the Board is to see the creation in this country of a peasant land-owning democracy—that is to say, that every person who leaves school is not turned into a labourer but is offered land also, then I feel that there is no necessity for this motion. In every Colonization Scheme when applications have been called more than double the number of applications than could possibly be entertained have been received. In view of this, Sir, there is no necessity for any sort of recruiting campaign to settle people on the land. On the other hand the aim of this Board should be to see that every young lad who leaves school is in a position to own land and not become a serf under another proprietor.

Regarding the point about shortage of cattle, I think tractor cultivation has solved this problem to some extent. I agree that there are some areas where tractor cultivation is not possible, but large areas in the dry zone have been successfully tractor-cultivated. If as suggested there is a serious shortage of cattle for wet zone cultivation, we should see that cattle are provided to cultivators at reasonable prices. There is no reason to refer this motion to a special sub-

committee and if it is necessary it could be referred to the sub-committee dealing with paddy cultivation."

Mr. A. M. Clement Dias—" A question has been raised whether boys from Royal and other colleges in Colombo will go to rural areas for paddy cultivation. I would like to say that at present boys from Royal College go three miles away to Mahawatta to do agricultural work. Although the emphasis is today on " Swabasha ", children in villages learn English. They get through their Junior which is of a very low standard today and their ambition is to get into a job somewhere as a clerk. Some parents of these village boys who own a few acres of land go to the extent of even selling it and keeping the sons at home idling till they get a job. The remedy I think is to make children of schools and colleges work in the field for a period of their school session so that they could, from their younger days, train themselves in cultivation work. Today conditions are quite different. Even if a young man with a fair education is jobless, he would not think of doing some cultivation. Sometime back it was the intention of the Minister to start agricultural and industrial schools all over the Island for the benefit of those who are out of school. I do not know whether any such industrial schools were started.

About the question raised regarding mamoties, I do agree that they differ according to the nature of land in each province. In Ratnapura District, the mamoties used for paddy cultivation are 14" × 6". The remedy is I think if we can indicate our specifications to the manufacturing firm, we could get down implements that will suit us.

In regard to the question of the shortage of cattle for cultivation purposes, the best that could be done is to take a survey of the cattle population in each province or district and arrange for the supply of cattle from surplus districts to other districts which are in need. I am sure that in certain districts there is a surplus of buffaloes. Recently I read in the papers that for several months a large number of buffaloes had been slaughtered in the slaughter houses of the Colombo Municipality. I think this Board should take up that matter as to why the Colombo Municipality should allow the slaughter of buffaloes in such large numbers.

Mudaliyar N. M. Abulcassim Marakar—" Mr. Chairman and Gentlemen, this is an important matter from the point of view of production. We are all aware that we desire to exist by ourselves as far as food is concerned. We are a rice eating nation and therefore we have to produce more rice. Today our production does not meet the demand. Therefore, Mudaliyar Wickremaratne's motion is very important from that point of view. The basic principles embodied in that motion are really commendable. Today the question of recruiting labour either by Government or by foreign organisations is not necessary. The Government must give the necessary inducement to the educated young lads. Educated youth of the country must be induced to take to the land. The dignity of labour in that field of activity must be recognised and it must be maintained. We must be conscious of our dignity that we have cultivated our land. What do we do now, especially the land owning class ? They do not even go to the field, but finance the cultivation operations. We should not only instruct our lessees to do the cultivation but as far as possible we must also participate in the cultivation activities. There are a number of items on which our personal attention is necessary. As far as land owners are concerned, they must resort to this method of production and cultivation. As far as young lads are concerned, they must be given sufficient inducement by Government to take to the land if self sufficiency is to be achieved in the production of rice.

At one time there was an actute shortage of buffaloes—I am not referring to neat cattle but buffaloes all over the Island. Today that shortage has disappeared, although there is a shortage in certain districts of the Island where buffaloes are needed for cultivation operations. Now what is done in certain districts is that a man who owns half an acre of land has to finance somebody else who owns buffaloes to do his cultivation. People resort to hiring buffaloes in this manner owing to the acute shortage that exists at the present time. There is an acute shortage of labour too, but not the type of labour that Mudaliyar Wickremaratne refers to in his motion. Actual labourers are

needed for cultivation purposes and that shortage still exists, and the remedy is for Government to come to the rescue of the cultivators. There is one important point in this motion and that is that Government officials and officers of some authority should induce young lads to take to agriculture earnestly by their presence at these various activities, and by organising demonstrations in different areas. When these demonstrations are held once or twice a year, then it becomes an islandwide feature. Nobody will feel that just because a cultivator is old and uneducated he is an unwanted element in this country. Today the position is entirely different, and the cultivator becomes an important element. The cultivator is an important individual on whom the country depends for food and therefore sufficient recognition must be given to these young lads by giving them sufficient inducement, official recognition, official support and by seeing that an organization is set up to enable these young lads to take to the field with a sense of dignity and honour.

As regards a Sub-Committee for this purpose, I think I agree with my friend that there is no need for such a committee as it can be referred to the Paddy Sub-Committee. But if the house feels that this motion is so important that a Sub-Committee is essential to go into it fully, I have no objection."

Mr. K. W. Devanayagam—"Sir, I like to touch on one point in this motion and that is about draught cattle. I think the idea that draught cattle were absolutely essential for paddy cultivation is now very antiquated. I come from the Eastern Province where a large amount of paddy cultivation is being done. Now the cultivators use tractors for their paddy cultivation and not only for ploughing but even for threshing machinery is used and the buffalo is completely eliminated. To find draught cattle for those areas is a very very old idea. I am sure most of you will agree that there was a time when these cattle did a tremendous amount of damage to the cultivators of this country because the owners of cattle had never learnt to look after their cattle. Their cattle were let loose on the high road and they often fed on others cultivations. Therefore, in my opinion the question of making available to cultivators draught cattle is not one of such importance. I feel that draught cattle will not be necessary and that more and more mechanised cultivation should be introduced into this country if we are to produce more food.

Chairman—"We have had the views of some of the members of the Board on the issues raised by Mudaliyar Wickremaratne. I think, as Mr. Ellepola has suggested, this is too big a subject and therefore would like to commend the proposal that it be referred to a Sub-Committee. Now the question is whether it should be referred to a Special Sub-Committee or to the Paddy Sub-Committee."

Mr. D. B. Ellepola—"I do not know the terms of reference of the Paddy Sub-Committee. If it is possible to include it in that I am prepared to withdraw my resolution."

Chairman—"I do not think the Paddy Sub-Committee has any special terms of reference. It deals with all matters relating to paddy that come up before this Board. In the circumstances I think it would be wise if the Paddy Sub-Committee can go into this question with a few additional members if necessary. With your approval I suggest that Mr. Ellepola and Mr. Kenneth Morford be co-opted to the Paddy Sub-Committee for investigating this matter."

At this stage Mr. Morford said he would like to withdraw from his appointment to the Sub-Committee as Mr. Ellepola was a more experienced man than himself and as he felt the co-option of one member was sufficient.

Chairman—"For the information of members I would say that the Paddy Advisory Sub-Committee consists of the following :—

Dr. M. F. Chandraratne (Convenor)
Mr. A. Godamune
Mr. Anton Ponnampalam, J.P.
Mr. U. B. Unambowe, M.P.
Mudaliyar S. Armstrong
Mr. A. M. Clement Dias
Gate Mudaliyar N. Wickremaratne
Mr. S. Sivapalan
Mr. S. H. Mahadivulwewa, M.P.

The Sub-Committee might be allowed to co-opt any other members, if necessary, for the consideration of this subject. I think we should have the advice of some animal husbandry people on this matter and would

suggest that Mudaliyar Wickremaratne, Dr. T. M. Z. Mahamooth, Deputy Director, Animal Husbandry, and Mudaliyar Abul Cassim Marakar be also co-opted to this Sub-Committee."

The Board unanimously agreed to the the names suggested by the Chairman for co-option to the Paddy Sub-Committee to go into Mudaliyar Wickremaratne's motion.

Chairman—"I may say that in recent years there have been attempts made by the Director of Food Production to bring in school children to partake in transplanting and like operations. "Wap magul" ceremonies were also started recently in order to encourage groups of people to join in paddy cultivation ceremonies. We had school children and people from the highest in the land to the humblest at these festivities. This was definitely a measure taken to prove to the people that paddy cultivation was an honourable occupation which all could well be employed on.

There was reference again to educated youth. I would like to point out to members of this Board that Government is shortly embarking on a pilot scheme for the settlement of educated youth in the Northern Province. An area of 800 acres at Paranthan which was previously a cattle farm under the Department of Agriculture is to be converted into a colonization scheme for educated young men, and 250 young men from the Northern Province are going to be settled on this land on the 9th of May. There is going to be a formal opening in a few days and this is the first big experiment in the colonization of educated youth. I think we should watch this experiment with great interest because if it succeeds, it will no doubt be followed by others in different parts of the country. I have mentioned this for the information of members."

Chairman—"We might now proceed to the second part of Mudaliyar Wickremaratne's resolution."

Gate Mudaliyar Wickremaratne—"The wet area of this Island has been cultivated to the very end, and now there is a scheme of giving land to the unemployed people. In the wet area, as I said before, we require cattle not only for agricultural purposes but for milk purposes. I am personally against mechanization because it will only bring our lands into a state of disrepair. When heavy machinery is used on our lands where we get a rainfall of about 70 inches, the soil will be eroded and nothing will be left out for cultivation. During the time of the late Mr. D. S. Senanayake, he definitely refused to extend the area under tea or rubber, and he ordered that the rest of the land must be utilised for food production. As the matter stands today we have utilised every available forest and village reserve for the cultivation of rubber and tea and what is left to us is about hundred thousand acres. If they are going to utilise some more land for tea and rubber, we will have nothing left for food production, and we will have to depend on foreign countries to sell our tea and rubber. In the first place we must provide land for the growing population of these wet zone areas like the Western Province, Galle District and such other places where they have no place to move to. Could you send these people to Minneriya and Gal Oya and such other places? What we have to do is to reduce the area under tea and rubber instead of increasing it and utilise that area for food production. When I brought up my resolution last time I did not know the correct position of the Rubber Rehabilitation Scheme, but since then I wrote to the Director of Agriculture and he referred it to the Rubber Controller who very kindly gave me the report. The Rubber Rehabilitation Scheme I may say I thought would allow some of the rubber land to be used for food production and the settlement of people. But now I find that the Rubber Rehabilitation Scheme is destroying all economic crops except rubber. It is a very serious question. I think the Chairman of the Re-planting Board must consider the question and not take advice of experts. Rubber was planted in areas which flourished with trees like jak and plantains. Now at least the area under tea and rubber should not be extended further.

Therefore, Sir, my suggestion is that this Board should bring to the notice of the Minister that no more land should be given for rubber or tea in the areas of the country in accordance with the policy of the late Mr. D. S. Senanayake."

Chairman—"Do you want to bring this up as a formal resolution?"

Gate Mudaliyar Wickremaratne—"No, Sir, I do not want to pass resolutions because they mean nothing. I will be satisfied if this is recorded in the minutes and the minutes are sent to the Minister."

Mr. S. Pathmanathan—"You will recall, Sir, that when Sir Oliver Goonetilleke presided at the inaugural meeting of this Board, he said that it was very essential that the major industries should go side by side with the development of food production. Mudaliyar must understand that the country must earn foreign exchange to maintain its standard of living; and unless we have a certain amount of produce to earn our foreign exchange we cannot maintain this standard. That was the reason why when Sir Oliver Goonetilleke was Minister of Agriculture, he encouraged the Rubber Planting Scheme. We have got down high yielding material for rubber which yields three or four times as much as what the ordinary rubber could produce. A similar scheme is now being formulated for tea. We are also aware that the Tea Research Institute produces as much as a thousand to two thousand pounds of tea per acre. Therefore, you will realise that it is very important that we cannot afford to neglect the present plantations of tea, rubber and coconut because our standards of living will go down. Perhaps as far as coconuts are concerned, if we do not extend the cultivation in new areas, we might not have sufficient even for the consumption of our people of this country.

As far as new land is concerned, the Hon. the Minister addressing the Ceylon Association in London has definitely stated that there is no land available for the extension of tea or rubber. He has definitely made this important pronouncement at the Ceylon Association in London and has said whatever land was available was going to be conserved for the development of paddy and other food crops for consumption of the people of this country. But I want to tell Mudaliyar that as far as rubber is concerned, it is very essential that we should export at least 100,000 tons of rubber if we are to get the money to provide your manures, machinery and implements and the various other necessities which are vitally important for the standards of this country."

Senator Thomas Amarasuriya—"Sir, if this motion is implemented, it is going to have a serious effect on the progress of this country. As you all know the very existence of this country depends on the revenue derived from these two industries—tea and rubber. The mover of this motion says there is a serious shortage of land in the wet zone. Secondly he says that in spite of the growing population of this country no more land should be given for the cultivation of tea and rubber. In other words he wants formal legislation introduced that hereafter we should not grow any tea or rubber in this country. He commented about the Rehabilitation Scheme. This is a scheme for replanting existing land with rubber and not new land. Even as it is, if you want to plant tea or rubber in new land you cannot do so without obtaining a permit. You can replant or rehabilitate existing land, i.e., give up the unproductive old rubber and replant with new rubber. In short, Sir, I am very sorry that an experienced agriculturist like Mudaliyar Wickremaratne had introduced a motion like this, because it is, in other words, going to affect the revenue of the whole country. We all know that 65 per cent. of the revenue of this country is derived from the three major industries. He says that this should be done to meet the needs of the growing population. It is to meet the needs of the growing population that Government has started village expansion schemes. As far as I am aware some tea estates Upcountry have been acquired for village expansion and I think they have now decided to acquire no more. If Mudaliyar Wickremaratne's motion is adopted, it will be very detrimental to the agricultural population of this country and I strongly oppose it."

Mr. G. B. Portsmouth—"Mr. Chairman and Gentlemen, I would also like to oppose this motion particularly because it was pointed out at the Tea Research Institute Conference that those vitally interested in the economy of this country should improve

the tea industry by replanting and by new planting of high yielding varieties. I do not think we have any reason at all for a body of this nature to accept motions of this sort that tend to restrict the growth of development. What we are all concerned with is the best utilization of land whether it be for tea, rubber or coconut. No future planned development will be kept up by this type of motion."

Mr. M. Atkinson—"I have a great deal of sympathy for this motion. The Minister of Agriculture has made it clear that tea, rubber and coconut industries produce 60 per cent. of the revenue of this country, in the form of taxes that are levied. What we are concerned with is the value of an acre of land to the State. A villager might be able to bring up a large family on an acre of land at very little cost. But today a modern tea plantation costs Rs. 3,000 an acre to bring it into bearing. Practically the whole of this amount goes as wages to the people who are employed. It costs Rs. 1,500 for an acre of rubber or coconut. These are facts that we must bear in mind and I consider that a few acres of land well cultivated are far better than many acres of unplanted land."

Chairman—"I see here the Director of Land Development, Mr. Fonseka. Perhaps he might like to say a few words."

Mr. J. V. Fonseka, Director of Land Development—"Only one fourth of the land area of this country is cultivated so that on the face of it there appears to be no shortage of uncultivated land. Of this uncultivated land, however, not more than, I believe, 3¼ million acres can be cultivated at all, and even of this extent only a part can be cultivated with paddy. Paddy cultivation requires irrigation and it cannot be said that the Government will permit the cultivation of irrigable land with rubber or tea in preference to paddy. There is, therefore, no conflict as regards lands that can be cultivated with paddy and lands that cannot, and I do not see any point in abandoning such lands as cannot be cultivated with paddy.

It might interest the House to know that approximately 20,000 acres of new irrigable land are being developed and made available for cultivation with paddy every year under major colonization schemes."

Gate Mudaliyar Wickremaratne—"I am thankful to Mr. Fonseka for supplying us with facts in regard to land available. But as regards Mr. Pathmanathan's idea, I will never accept the economic theories of the previous Minister of Agriculture and Food. When the Agricultural Society was started the population was 3½ million and the revenue of the country was Rs. 30 million. Today it is Rs. 900 million. If they cannot manage with such a sum what is the use of these finances. Selling of rubber to outside countries is "Old economics". I got a shock when Sir Oliver Goonetilleke said at the first or second meeting of the Central Board that he must have rubber and tea. Poor Mr. Senanayake had said that no more rubber and tea should be planted. The economy of a country must be decided according to the nature of the country and not according to a western method of political economy. During the first world war our rubber was sold at 10 cents a lb. and coconuts at Rs. 10 per thousand. I hope Mr. Pathmanathan will appreciate my point of view."

Chairman—"I do not think the Government will go wrong in deciding on the best use of the land. I think the Government has all along done their best in the cause of food production. A Land Utilization Sub-Committee was appointed about two years ago which went into this question very thoroughly and determined which lands should be used for the further development of paddy. The rest of the land was considered for development under other types of food crops. Dry farming loomed large in the eyes of the Committee and also land suited for perennial crops like tea, rubber and coconut. I think it would be fatal for a Board like this to pass resolutions that no land should be set apart for tea, rubber or coconut. I think this is a matter for a land utilization expert to determine. I am as keen as Mudaliyar to see that food production is encouraged in the country but the main thing to consider is the best use to which a particular land should be put, and that can only be determined by an expert bearing in mind the various considerations

such as the requirements of the peasantry, &c. If you want me to ask for a vote on this from the Board, I shall do so, but I think the general opinion is to leave it alone."

Gate Mudaliyar Wickremaratne—"I do not want a vote, what I want is that it be included in the minutes."

Part III of Mudaliyar Wickremaratne's resolution was next taken up for discussion.

Gate Mudaliyar N. Wickremaratne—"I propose that this part of my motion be referred to the Paddy Sub-Committee. I sent a resolution about rice milling on a previous Agenda and the Minister has accepted it and some steps have been taken that the miller will not buy paddy from the cultivator because he was paying less. According to the present arrangement if the miller wants to he should buy from the Co-operative Societies. Now the miller is unable to buy from the cultivator and the cultivator has to somehow sell his paddy to the Co-operatives and it is not in all cases that the real co-operation expected from these societies is forthcoming. What I say is, why not let there be some co-operation between the miller, the cultivator and the Government ? During the State Council days a proposal was made to hand over the milling of paddy in this country to a foreign firm. We have heard what has happened in Burma. The Burmese could not send an ounce of rice out because they had got into an agreement with the miller. They came to Ceylon and wanted the consent of this Government to undertake the milling of paddy. On representations being made to the Ministries a committee of the various Ministries met and decided not to hand over to them the milling of paddy. Then Mr. Bassett started the first mill at Anuradhapura. After that, people have taken to it and now they are doing it. Now the Director of Agriculture or the Director of Food Production must intervene in this matter and see that there is some harmony. We must have our rice millers and we must pay a good price to the cultivators. As you know we have different grades of rice. What Mr. Bassett did was to put all the paddy together and mill it. We have par-boiled rice, unboiled rice, and different varieties like Muttu Samba, Heeneti, &c. Our rice millers have made a great mistake in this respect. We must teach them to mill separately the different varieties. I therefore suggest that somebody must take an interest and arrange that the miller be more reasonable because at the present time milling is very unsatisfactory. For this reason I put the motion before the House."

Chairman—"I think the representative from the Marketing Department will be able to give some information about the milling arrangements at present."

Mr. L. B. Rajakaruna, Deputy Commissioner of Marketing—"I am very pleased about Gate Mudaliyar Wickremaratne's proposal. According to the motion here, the first sentence says that the rice milling industry is a necessary adjunct. Now that we have increased the production of paddy more and more, rice milling has become not only a necessary adjunct but vital. You remember Mr. Chairman that the question of a guaranteed price scheme was discussed before this Board last year. At the meeting the question of Government buying rice from private millers was discussed. In fact it was even suggested that as the Government had guaranteed the price of paddy to the producer, it should not purchase rice from private millers. It was also suggested at that time that the miller was not paying the guaranteed price to the producer. Recently we have worked out a scheme whereby we have registered 450 millers in different parts of the Island from whom Government purchases rice on condition that the miller buys an equivalent quantity of paddy from Government's stores. A reasonable price has been fixed for the miller and we have had no difficulty at all because the miller buys the paddy from Government and mills it at his mill and then sells it back to Government. Government collects the paddy and sells it to the miller at Rs. 12 per bushel. Government in turn buys a bag of rice from the miller at Rs. 64.75. This price allows to the miller a reasonable margin of profit for the expenditure he would incur in par-boiling the paddy and milling it. Therefore, Mr. Chairman, you will see that there is a certain amount of relationship between the paddy cultivator on the one hand and the Government on the other. The Government pays the cultivator a

guaranteed price for his paddy. We issue the paddy to the miller at the same price and the miller in turn offers it to the Government at a fixed price. This condition whereby we have stipulated that millers should buy paddy from Government is only in respect of rice they sell back to Government. Apart from this, they have the option to buy other paddy. The rice from the paddy that he buys from outside can be sold in the open market.

Coming back to Gate Mudaliyar Wickremaratne's suggestion that the miller should mill different varieties of paddy separately I wish to state that we have found it difficult to induce the cultivators to sell to Government different varieties of paddy. The paddy which we get is normally the mixed variety, so that the miller has to mill paddy not from specific varieties but from mixed varieties. One reason for this is that even if the cultivator is able to give separate varieties, the present storage is inadequate to stock that paddy separately in our stores. I suppose once we get the necessary storage this may be possible."

Mr. A. Divitotawela—" May I ask whether there are various prices fixed for different districts by the Marketing Department ? "

Mr. Rajakaruna—" There is a refraction allowed for different varieties."

Mr. Divitotawela—" Paddy sent from the Uva Province is taken at not more than Rs. 10."

Mr. Rajakaruna—" If the variety is a long grain like " dik wee " the price can vary."

Mr. Divitotawela—" Yes, they are long grains."

Mr. Clement Dias—" I was told that in some parts of the Kurunegala District, when paddy is bought by the co-operatives, a certain percentage is taken extra, sometimes as much as a bushel, for driage."

Mr. S. C. Fernando, Commissioner for Co-operative Development and Acting Director of Food Production—" I am not aware of that. There is no authority for anybody to charge an extra bushel for driage. All we are trying to do is to prevent the miller buying paddy for less than Rs. 12 per bushel. We have restricted the operations of the miller so that he cannot buy paddy for anything less than Rs. 12 a bushel. If he brings milled rice he must furnish proof that the paddy was bought at Rs. 12 per bushel.

Chairman—" I would like to suggest that we add the name of the Director of Food Production to our Sub-Committee on paddy. I think that his name must be included because he is very intimately connected with the cultivation of paddy."

This proposal was agreed to by the Board.

VII—Resolution to be moved by Mr. Ray Wijewardena

" That in view of our increased demands on the soil for greater productivity and the present high cost of artificial fertilizers that all Municipalities and Urban Councils be prevailed upon to convert sewage and garbage into organic manure for sale to planters and farmers instead of disposing of them through destructors, incinerators, dumps, &c., and that a section of the Department of Agriculture be devoted to research in organic and humus husbandry in order to develop the most appropriate means of restoring organic fertility and humus to the soils of this country, particularly where they suffer worst through erosion and oxidation."

Mr. Ray Wijewardena moved the above resolution formally and Mr. J. M. Sabaratnam seconded it.

Mr. Ray Wijewardena—" Mr. Chairman and Gentlemen—Only a few days ago our Hon'ble Minister for Agriculture, in reply to a question as to whether a fertiliser plant could be set up in Ceylon, said that although he agreed with the necessity for such a factory he was not certain whether it would be possible to establish one, in view of the present financial position of the Government. Our approximate average yearly imports of the main NPK fertilisers are 72,000 tons of sulphate of ammonia, 42,000 tons of saphos phosphate and 30,000 tons of muriate of potash. That then is our target for the present, with extra in hand for future developments.

Gentlemen, would it surprise you to know that very nearly half this quantity of fertiliser, in the form of sewage and garbage is

at present disposed, incinerated and otherwise destroyed, every year by the Municipality of Colombo alone ? And to destroy it the 35,000 taxpayers in Colombo pay Rs. 1,600,000.

Throughout the world, Municipalities, Urban Councils and Village Committees are now realising the tremendous potential of organic fertiliser—acclaimed universally as the most suitable form of fertiliser for agriculture—present in sewage and garbage, hitherto considered as waste products, deserving only of destruction. Fortunately this era of sanitary suicide is receding and the accent is rather on "conversion" than destruction.

I recently had the opportunity of seeing a number of these plants in operation in Germany, France and England. Those in the towns and cities were tremendous ; those in the villages and suburbs more modest in size, but still coping with the entire output of those two valuable raw materials—sewage and garbage. The process is the well-known one of composting and although towns and cities have continuous-flow plants which manufacture mature compost with a carbon to nitrogen ratio of well below 20, within five days, the suburbs and villages composted using the well-known Indore method of heaps. In every one of these progressive institutions I was amazed by the simplicity of equipment and the cheapness with which the compost was produced. The average price was about Rs. 5 per ton, dried to a moisture content of 40 per cent. and baled ready for easy removal by the farmer.

One of the reasons why sewage is treated before disposal is to destroy pathogenic bacteria and it will interest you to know that the heat evolved within these compost plants causes the temperature of the mixed sewage and garbage to rise to above 150° F. within two or three hours, and this temperature is maintained until the heap is broken down. Amongst the commoner pathogenic organisms bacilli tuberculosis is the most heat resistant but these have been proved unable to survive temperatures above 130° F. for longer than ten minutes, while very much lower temperatures and shorter periods of time would prove absolutely lethal to organisms associated with erisypelis, pneumonia, diphtheria and typhoid and even anthrax. It is in fact Nature's way of dealing with these bacteria if only we would stop trying to oppose the forces of Nature and instead make use of them to our advantage.

So much for the theoretical aspects of the matter. I have since returning devoted much time and study to this matter to investigate the possibilities of converting for example, the sewage and garbage of the city of Colombo, into organic fertiliser and the results are startling. Very briefly the 335,000 population of Colombo produce 250 tons of garbage and 100 tons of solid excrement per day, which after screening to remove bottles, metal, rags, &c., will produce after composting, very nearly 350 tons of mature organic fertiliser, with an approximate composition of 5 per cent. or 17.5 tons of nitrogen, 2 per cent. or 7 tons of phosphoric acid and 5 per cent. or 17½ tons of potash in immediately plant available form, in addition to 22 per cent. or 77 tons of organic matter with very low carbon nitrogen ratio, which in itself is capable of converting a great deal of the non-available nutrients in the soil and subsoil into plant available forms. Taken on an annual basis this compost would contain the equivalent of 30,000 tons of sulphate of ammonia, 12,500 tons of saphos phosphate and 12,000 tons of muriate of potash. As I said before very nearly half the total requirements of the Island. The cost of the plant would be very little, as most of the equipment is already available in various forms. Only the rapid five day composting horizontal cylinder is required. Costs for this completely mechanised and highly hygienic process would result in a sale price of between Rs. 5 and Rs. 7.50 per ton ex Mattakuliya and covering all depreciation and everyday operating costs. For a change the Municipality could work this section at a profit which need not be more than a modest one, considering its original loss of Rs. 1,600,000 annually !

So much for the potential immediately available through the waste products of the 335,000 citizens of Colombo. Multiply these figures by the population under every Municipality and Urban Council and you will soon appreciate that we can well supply very much more than our minimum require-

ments of fertiliser for Agriculture and at very low capital cost. The important thing to realise is that all the food being imported into and distributed around this country is actually fertiliser coming in, and the fact that it would be readily available to farmers at every town and city, makes it even more attractive as transportation costs are hereby greatly reduced. The vast sum spent annually in foreign exchange to bring these fertilisers into the country can be saved, particularly when you remember that these fertilisers cost approximately Rs. 150 per ton for a mixed fertiliser of equivalent NPK composition as the compost produced, but devoid of the 77 per cent. of organic matter so important to our tropical soils.

An interesting by-product for most Municipalities and Councils is methane gas, which is produced by just tipping the mixed sewage and garbage into a sealed digesting tank to ferment for about a fortnight before the composting process is commenced. During this period of fermentation in the digesting tank the anaerobic bacteria get to work on the hydro-carbons and produce methane gas which is very similar to town gas but has appreciably higher heat content and is quite odourless. The gas so produced can be piped into a gasometer and thence into the town gas supply, or else used to power the town's electricity generating machinery. Taking for example the case of Colombo once again, the methane gas which could be thus produced would be more than double the output of the present Gas Company ; that is about 1,400,000 cubic feet daily or the heat equivalent of 6,000 gallons of petrol. This gas could be utilised to power all the engines at the Kolonnawa and Pettah power stations, providing light and power for Colombo in addition to powering the machinery at the sewage and garbage works. The surplus could still be piped to supplement the town gas supply. The facts of these statements are certainly staggering as they mean that every Municipality can afford to light its town without any imported fuel costs whatsoever—providing electricity at a mere fraction of that produced even hydro-electrically ! After fermentation for gas the mixture of garbage and sewage is still in no way impaired for composting. In fact in the post-war German cities, the sale of methane gas entirely subsidises the composting process thus enabling farmers to purchase the compost produced for a mere Re. 1.50 per ton.

Gentlemen, what I have said must certainly appear startling but these are facts and just go to prove what we can do by trying to get along with Nature.

I now propose the resolution " that in view of the increased demands on the soil for greater productivity and the present high cost of artificial fertilizers, that all Municipalities and Urban Councils be prevailed upon to convert sewage and garbage into organic manure for sale to planters and farmers instead of disposing of them through destructors, incinerators, dumps, &c., and that a section of the Department of Agriculture be devoted to research in organic and humus husbandry in order to develop the most appropriate means of restoring organic fertility and humus to the soils of this country, particularly where they suffer worst through erosion and oxidation ".

Chairman—" I would like to say something on this subject. I was connected with this type of work, as Chemist, about 25 years ago. Compost making from road refuse and night soil was studied at that time in collaboration with the Medical Department. We worked for two years on the subject and a large number of local bodies, including the Colombo Municipality, undertook the process as a result. Of course at that time the only process we knew of was the agricultural process whereby the destruction of pathogenic organisms was secured by regular turning. The final product was secured and utilized as manure. The process was carried on for some time not only in Colombo but in other Municipalities as well. I think the price at which the final product was sold by the Municipalities was Rs. 5 per ton. Then for some reason or other the product did not find a ready sale. Whether it was due to transport difficulties I could not say. I approve heartily of the proposal put forward by Mr. Wijewardena because I am a great believer in putting natural waste into good use, and I would commend it to the Board for adoption.

Particularly in the light of the modern developments to which Mr. Wijewardena has referred by which compost could be made

available in 5 or 6 days, the motion should commend itself to the Municipalities, particularly the Colombo Municipality.

Mr. Wijewardena's efforts in preparing this comprehensive memorandum is very commendable, but I have to state that his analytical figures are a bit on the high side compared to those we have obtained for local samples. But I do not think we need quarrel over this issue. Our analytical figures were about 1/10th of what has been quoted by Mr. Wijewardena. I do not think, however, that it is the function of the Agricultural Department to undertake this work as the public health issue is involved in this. That was why we worked in collaboration with the Public Health Department. It is really one which concerns the Municipalities and other local bodies. We will be very happy to co-operate with any organisation that is prepared to undertake this work. With those reservations I would like to commend the resolution to the House."

Mr. C. A. M. de Silva—" The reason why compost manure did not catch on was because it failed to produce the desired results. The results were not as effective as 7 lb. of artificial manure mixture. On the contrary the results of compost showed diminishing results, while the results obtained by artificials were very encouraging. That is why it did not find a ready sale even at Rs. 7 and bulk handling was also cumbersome ".

Gate Mudaliyar N. Wickremaratne—" To get increased yields from paddy and other crops, we must have manure and Mr. Wijewardena should be congratulated for bringing up this useful resolution. Some time back I wrote to the Department about certain aspects of manuring and I agree that compost can do a lot for our crops. My personal view is that if this is left to the Municipalities, they will never do it. Therefore, what I suggest is that if some of our well-to-do gentlemen can form into a company and run this concern it will be very much better than waiting till the Municipalities do it and it would also be an achievement to our country. When the Japanese Experts were here, one of them told me that paddy fields in Japan are manured about thrice during one sowing season. Some of us do not manure our fields even once and how can we do it without the manure. Therefore, people like Mr. Pathmanathan, Chairman of the Low-Country Products Association, and other members here who own two to three hundred acres of coconut should think of investing some of their money in a venture like this. Most of our rubber, tea and coconut planters do not invest their money in useful ventures of this nature and they always believe in banking it safe. In a place like India it is quite different. They invest every available cent on some productive business."

Mr. G. S. Portsmouth—" This is a problem that must be recommended to the Research Institutes."

Mr. A. M. Clement Dias—" Mudaliyar Wickremaratne always makes reference to the poor man but today he has referred to the rich man. Today compost is available at Rs. 10 per ton. Some time back I sent a memorandum suggesting that all Village Committees, Town Councils, Urban Councils and Municipalities should take an interest in the manufacture of compost, and that it should be given to the cultivator at cost price. We should have more manure for our fields available. In Japan paddy fields are manured three times a year and they use about 800 pounds of manure per acre. In Ceylon we use only 56 lb. of manure per acre. But I am glad to say that I manure my fields three times a year and use about 250 lb. of manure per acre, and the results have been very good with a yield of about 130 bushels per acre."

Mr. Ray Wijewardena—" Mr. Chairman, I am aware that the figures which you have produced are very much lower than the ones that I have. But I got these from actual simple tests conducted and they were corroborated from similar tests from Germany, France, South Africa and England. I am personally at a loss to explain why we differ.

With regard to the demand in Colombo for compost, the composting plant in Prince of Wales Avenue produces about 12 tons a day which is booked long before the compost is ready. They never had to advertise because the demand was always in excess of the production. Most of it is taken away by owners of coconut estates. The difficulty of

bulk handling can be greatly reduced by extracting the surplus moisture and then compressing it into bales.

With regard to the point mentioned by Mr. de Silva about artificial manure, I entirely agree that artificials produce some immediate and startling results particularly where plantation crops are concerned. I would like to mention about Horakelle Estate which had two blocks, one under artificials for the last 30 odd years and the other under cattle manure. Now they have been rather startled by the drop in production in the area under artificial manure. Recently some officials of the Coconut Research Institute went there and found that not a single mother palm had been produced in the artificially manured area, while the area under cattle manure and mixed manures was all right.

Chairman—"I do not think further discussion on this matter is necessary. We should, I think, accept this resolution in principle and recommend that this be a subject for investigation by the new Industrial Institute. If you would leave it to me to pursue action on the resolution and to ascertain how best we could implement it, in consultation with Mr. Wijewardena, we will probably satisfy the purpose of the mover of the resolution."

The Board agreed to this proposal.

VII—Reports of the Sub-Committees

Chairman—"The next item is the consideration of the Reports of the Sub-Committees. The draft Report of the Animal Husbandry Committee, has just been circulated and Dr. Mahamooth will give you a brief resume of it."

Dr. T. M. Z. Mahamooth, Deputy Director of Animal Husbandry—"Mr. Chairman and Gentlemen—the Committee met twice and five items were discussed. The first subject that was discussed was in regard to veterinary aid. It was felt that rural areas were not fully served by the Veterinary Services and therefore that more Veterinary Surgeons should be appointed to the ranges so that each officer will have a small area for efficient working. It was suggested that one Assistant Veterinary Surgeon should be appointed for each D. R. O's Division.

The next item was in regard to the payment of an adequate travelling allowance. It was felt that the present allowance for travelling should be increased. Item 3 was in regard to the control of animal diseases and the Committee felt that more attention should be paid to the control of foot-and-mouth and tick-borne diseases. As regards propaganda in animal husbandry, the Committee felt that while it appreciates the usefulness of films from foreign countries it would be more desirable to show films of local interest on the items that I have mentioned so that they would be of use to the rural population.

The next item was with regard to the release of the Quarantine Station. At the present moment there is no provision for importation of cattle for breeding purposes to Ceylon. The quarantine station at Slave Island was taken over by the Colombo Municipality for the quarantine of goats imported for slaughter. Since the accent is placed on increase in quality and quantity of cattle, people have made inquiries from India and Pakistan about imports, but at the moment importation is at a standstill. It was therefore felt by the Committee that steps should be taken to ask for the release of the Quarantine Station as early as possible.

Item 7 was in regard to animal husbandry in the Jaffna Peninsula. During certain times of the year owners of cattle are hard put to find adequate supplies of fodder. The price of straw soars up and the people experience much difficulty in finding grass for their cattle. It was therefore felt that in order to encourage livestock owners in the Jaffna Peninsula, Government should be requested to instal power driven balers in areas where paddy straw is in abundance, e.g., Hingurakgoda, Paranthan, &c., so that straw could be baled and transported by train to Jaffna.

Finally, in regard to a booklet on cattle-keeping, it was felt that a small booklet on breeding, feeding, management and diseases of cattle be published in all three languages."

Chairman—"I think this report might possibly be considered with advantage along with Mr. Schrader's resolution at the next meeting. Of course a large number of these are administrative matters and could be dealt with by the Department, as, e.g., a book on cattle-keeping, &c. The question of the Quarantine Station has already been taken up with Government and in the interests of all cattle owners we will press for its return very strongly.

I have already told you that the Treasury has agreed to the addition to the cadre of Veterinary Surgeons. Ultimately I hope we could increase the number to serve the needs of every D. R. O's Division in the Island."

Mr. S. C. Fernando, Commissioner for Co-operative Development and Acting Director of Food Production—"Since I might not have the opportunity of being present on the occasion Mr. Spencer Schrader's memorandum is taken up, I should like to clarify a point arising from it. Item 6 of the memorandum states that under the Food Production Regulations the exemption allowed in respect of "Sinhala" type cattle is a quarter acre per head as compared with 1 acre and 2 acres for the medium and superior types of cattle respectively. I must say that the law is not rigid on this point and that any person having "Sinhala" type cattle coming within or near the medium grade could get the same concession allowed to the latter class. For example, Mr. Spencer Schrader refers to a Sinhala type cow which yielded 9 pints of milk per day. Now I am sure anybody having "Sinhala" cattle of this standard could easily obtain the exemption allowed to medium type, viz., 1 acre per head."

Chairman—"Mr. Richards who is the Convenor of the Minor Products Sub-Committee will speak to you on the activities of that Sub-Committee."

Mr. A. V. Richards—"The report of the Sub-Committee has been circulated to members of the Board for consideration. In all, four meetings of the Sub-Committee were held. At its inaugural meeting the Sub-Committee decided on its functions, which were:

(1) to explore the possibilities of expanding and improving the minor products grown in Ceylon;

(2) to explore the possibilities of introducing other economic minor products to Ceylon.

In all, the Sub-Committee has decided on about 20 minor products, individually and also in groups. The Sub-Committee decided to submit interim reports to the Board in due course and at this meeting it has pleasure in submitting its report on Cacao.

In this report a brief survey has been made of the cacao production and its exports from Ceylon to various countries and also of diseases and pests which threaten its production in other countries, especially in Africa and tropical America. Emphasis is made of the fortunate position Ceylon is, in being fortified against such diseases. There has been considerable replanting of cacao in rubber areas—to about 50,000 acres, 55 per cent. being in the Kandy district and 33 per cent. in the Matale district.

A review was made of the climatic and soil requirements. Cacao can grow well at an elevation of 500 to 2,000 feet with fairly distributed rainfall of not less than 60 inches and not more than 100 inches, and temperatures not below 60° F.

Reference was also made to the Department of Agriculture, Trinidad, West Africa, New Guinea and Indonesia from where certain high-yielding clones have been obtained. We have been fortunate in being able to get such high quality clones. They have undergone a period of quarantine at Kew and Heneratgoda. A brief description of the vegetative propagation of cacao is also given in the report.

Under-planting in cacao is the subject in which the Committee has really been interested. The costs of such under-planting have been supplied by Mr. Atkinson, who has been a pioneer in this field, Mr. Johnson of Urugala and the Superintendent of Pitakanda Group, Mawatagama. The Committee has considered three types of land in which cacao could be encouraged. That all lands above 1,200 feet in the Kandy-Matale district which are presently under uneconomic rubber be put under cacao. The Committee feels that a sum of Rs. 450 is adequate as a subsidy for under-planting uneconomic rubber with cacao. The Committee has also recommended that since

there is already a scheme of assistance for development of Crown land as peasant settlements in either tea, rubber or coconut, &c., cacao should also be included and that a subsidy of Rs. 750 be paid for the development of Crown lands under cacao. The third type of land which the Committee has considered is private land which is not presently under rubber but which may be found suitable for cacao. The Committee recommends that the same subsidy as for the development of uneconomic rubber lands be given for the development of cacao under this category. Finally the Committee recommends that the services of an expert in cacao be obtained through the F. A. O. or Colombo Plan to work on the problems relating to the control of Sickle leaf, Helopeltis, &c.

Chairman—" You have heard a very good report of this Sub-Committee which has laid great stress on the cacao crop. I think a report of this nature needs a little time for discussion. May I suggest that we put this by for discussion at the first item on the Agenda of our next meeting so that those who wish to discuss it could do so ? I must thank the Committee for the systematic way it has proceeded with its work by taking each crop or group of crops successively and providing us with a valuable brochure thereon. I thank the Chairman and Convenor for the useful work they have done.

The Paddy Committee is not yet in a position to issue its report and I hope they will do so before the next meeting. The Committee has had to devote some time to the consideration of the Joint Report of the U. K./Australian Rice Mission and hence the delay. "

Mr. S. Pathmanathan—" We have recommended cacao mainly as a peasant crop because in the Gold Coast, you will realise, that cacao is essentially a vital product in their economy and the price is guaranteed for a period of ten years. It is not going to be a major industry. "

The suggestions of the Chairman in regard to the Sub-Committees and the consideration of their reports were accepted by the Board.

Gate Mudaliyar N. Wickremaratne—" I would like to ask one question, Sir, and that is, if the Minister is unable to attend the meetings of this Board why cannot he send even his Parliamentary Secretary ? He is a gentleman who understands the agricultural needs of the country and he can help us by way of useful criticism. "

Chairman—" I think it will be expecting too much to ask the Minister to attend every meeting of our Board. As Minister he has many urgent matters of the State to attend to and it will be impossible for him to be present at every meeting of the Board. I will certainly convey the Mudaliyar's wish, that if he is unable to attend, he be requested to delegate his Parliamentary Secretary to do so. "

The meeting terminated at 5.30 p.m.

N. P. WIJEYERATNE,
Secretary,
Central Board of Agriculture.

Peradeniya, June 13, 1955.

ANIMAL DISEASES RETURN

January–March, 1955

Province	Disease	Fresh Cases during the Quarter	Total Number to end of First Quarter, 1955				Balance ill at end of Quarter
			Cases	Deaths	Shot	Recoveries	
Western Province (excluding Colombo Municipal area)	Foot-and-mouth	48	48	—	—	48	—
	Rabies	81	81	—	81	—	—
Northern Province	Anthrax	60	60	60	—	—	—
	Rabies	1	1	—	1	—	—
North-Central Province	Black Quarter	38	38	38	—	—	—
	Rabies	2	2	—	2	—	—
	Haemorrhagic Septicaemia	52	52	50	—	2	—
North-Western Province	Foot-and-mouth	1,359	1,359	234	—	1,001	124
	Rabies	4	4	—	4	—	—
Central Province	Foot-and-mouth	72	72	—	—	33	39
	Piroplasmosis	2	2	1	—	1	—
	Rabies	8	8	—	8	—	—
Province of Sabaragamuwa ..	Rabies	9	9	—	9	—	—
Province of Uva	Foot-and-mouth	58	58	1	—	57	—
	Rabies	7	7	—	7	—	—
Eastern Province ..	Foot-and-mouth	172	172	—	—	172	—
Southern Province	Foot-and-mouth	3,732	3,732	435	—	2,787	510
	Rabies	3	3	—	3	—	—

Department of Agriculture,
Peradeniya, June 7, 1955.

T. M. Z. MAHAMOOTH,
Deputy Director (Animal Husbandry) and Government Veterinary Surgeon.

METEOROLOGICAL REPORT

January–March, 1955

SUMMARY

ORDINARY north-east monsoon weather prevailed generally over the Island during January, with rainfall mainly confined to the north-eastern hill-country and the southern parts of the Batticaloa District. Evening thunder-showers were experienced occasionally in the south-western parts. The weather was unsettled from 6th to 9th on account of a low pressure wave to south of Ceylon. There was widespread rain with gloomy skies on the 6th and 7th, which was considerably heavy in the north-eastern hill-country and the southern parts of Batticaloa District, several stations recording daily falls over 5 inches. These rains resulted in disastrous floods in Uva Province and the Gal Oya Development area. The low pressure wave moved westwards and strengthened into a depression over the Maldives on the 9th, causing considerable damage to house and property. The north-eastern parts experienced heavy rain on the 17th and 23rd also. The weather conditions were dry over the whole Island on the 14th, 28th and 31st. The monthly rainfall exceeded 30 inches in the north-eastern hill-country, Hendon Estate in Rangala area totalling as much as 55.46 inches and St. Martin's (Upper) Estate 50.76 inches. From this region there was a gradual decrease in rainfall towards the east, and monthly totals in the southern parts of Batticaloa District were of the order of 20 inches. In the north-eastern low country the rainfall ranged from 10 to 15 inches and in the south-western parts from 5 to 10 inches, while in the North-Western Province and in Jaffna Peninsula it was below 5 inches. Least rain (totals below 2 inches) occurred in Chilaw-Narammala area. The rainfall was considerably above normal in the north-eastern hill-country and in Pottuvil area, where the excesses exceeded 10 inches. Appreciable deficits occurred in the neighbourhood of Batticaloa, and scattered in places, in the North-Western and Sabaragamuwa Provinces and in Deniyaya area. Elsewhere over the Island the rainfall did not deviate much from average.

Several low pressure waves moving westwards to south of Ceylon were responsible for the most unusual weather experienced over the Island during February. They caused heavy rain in the area extending from sea coast in the southern parts of Batticaloa District up to the hills, and stimulated thunder activity in the south-western low and mid-country, mainly in Kalutara and Galle Districts. Their influence was, however, limited, and did not extend to the northern parts of Ceylon—to north of Chilaw-Trincomalee, where the conditions were mainly dry. The severest of these low pressure waves occurred on the 7th and 8th, when the southern parts of Batticaloa District as well as the Gal Oya Catchment Area experienced heavy rain, over 30 stations recording daily falls exceeding 5 inches. Before the floods that resulted from these rains could subside, another low pressure wave caused heavy rain again in the same area, on the 12th and 13th. Although the rainfall on this occasion was less, it helped to prolong the floods in the area, causing great damage to house and property in the Gal Oya Valley. It also caused the Gal Oya Reservoir to overflow, for the first time since its construction a few years ago. Similar weather was experienced in a February, previous to this, in 1944. The region affected was nearly the same, but the rainfall was heavier, there being a number of stations which recorded monthly totals over 25 inches. Greater monthly totals in February, 1955, were generally of the order of 20 inches, and occurred in the coastal area near Kalmunai and in the north-eastern hill-country. Elsewhere in the eastern regions, extending from Kalmunai to the hills, the monthly totals were above 10 inches. In the south-western low and mid-country also the rainfall generally exceeded 10 inches, with a few totals over 15 inches in Pimbura-Udugama area. The rainfall was below 2 inches in the northern and north-western parts, a few stations in Jaffna Peninsula recording no rain at all. The rainfall was above normal in the southern half of the Island, remarkably high excesses, of the order of 15 inches, occurring in the southern parts of Batticaloa District, and scattered in places, in the north-eastern hill-country and in Kalutara and Galle Districts. The deficits which occurred in the north and northwest were slight, due to the fact that February averages in that area are low.

The weather over the Island was practically dry during the first fortnight of March. Inter-monsoon thunder activity commenced about the 13th and continued till the end of the month. At the beginning the rainfall was mainly confined to the southern half of the Island, but towards the end of the month it extended to North-Western and North-Central Provinces, too. Some stations in the south-western mid-country experienced rainfall almost every day during this period, with heavy falls occasionally. The greater monthly totals ranged from 10 to 20 inches and occurred in the south-western low and mid-country and among the Haputale Hills. In the Northern and Eastern Provinces and in some parts of North-Central Province the rainfall was mainly below

2 inches, a few stations along the northern and north-eastern coasts receiving no rain at all. The rainfall was generally above normal in the south-western parts, where the greater excesses mainly exceeded 5 inches. The rainfall was below normal in the northern and eastern parts, but the deficits were generally small.

A. P. KANDASAMY,
Acting Director.

Station	January									February			
	Temperature				Humidity		Rainfall			Temperature			
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)	Total	Offset	No. of Days	Mean Maximum	Offset	Mean Minimum	Offset
	°	°	°	°	%	%	in.	in.		°	°	°	°
Anuradhapura ..	82·6	—0·7	71·0	+1·8	83	98	5·90	+0·10	20	86·0	—1·1	70·2	+0·9
Badulla ..	75·7	—0·5	65·4	+1·6	86	95	19·72	+9·40	26	78·1	—0·9	64·8	+1·7
Batticaloa ..	81·6	+0·1	75·9	+2·4	80	86	7·69	—5·19	24	82·2	—0·7	74·3	+0·6
Colombo ..	86·1	—0·4	71·9	+0·1	72	90	7·05	+3·09	12	85·3	—1·9	72·3	+0·2
Diyatalawa ..	70·3	—1·5	60·0	+2·3	86	94	11·82	+5·18	20	75·1	+0·2	58·9	+2·1
Galle ..	84·1	+0·3	73·3	+0·3	78	88	5·57	+1·69	11	84·2	—1·0	74·1	+0·4
Hambantota ..	83·6	—1·4	73·4	+0·7	79	90	9·34	+5·34	19	84·8	—1·2	73·5	+0·5
Jaffna ..	83·1	+0·1	74·3	+2·2	72	84	3·84	—0·57	7	85·2	—0·4	72·0	—0·3
Kandy ..	81·0	—1·2	67·1	+2·3	73	87	7·23	+0·49	22	83·3	—2·1	66·1	+1·9
Kankesanturai ..	82·9	—	75·7	—	79	84	2·97	—0·44	9	84·8	—	73·8	—
Kurunegala ..	84·5	—2·0	70·7	+0·8	74	95	3·35	—1·76	12	87·4	—2·6	70·1	+0·5
Mannar ..	82·9	—0·4	75·5	+1·3	76	84	6·40	+2·56	15	85·0	—1·2	74·9	+1·1
Nuwara Eliya ..	65·2	—2·5	52·6	+5·6	80	84	10·50	+3·54	22	67·7	—1·9	51·1	+5·9
Puttalam ..	85·6	+0·1	71·7	+1·7	75	93	3·91	+0·48	16	87·7	—0·6	71·2	+0·9
Ratmalana ..	85·3	—	72·5	—	68	88	4·70	+0·55	11	86·6	—	73·1	—
Ratnapura ..	88·1	—1·2	71·3	+0·2	75	95	9·98	+3·72	15	89·8	—1·8	72·4	+1·1
Talawakele ..	72·3	—1·9	58·7	+3·2	72	83	4·67	+0·80	15	73·6	—2·8	56·9	+2·4
Trincomalee ..	81·4	+0·9	76·7	+1·4	80	82	12·81	+4·50	18	82·2	—0·3	76·8	+1·0

Station	February (contd.)					March								
	Humidity		Rainfall			Temperature				Humidity		Rainfall		
	Day	Night (from Minimum)	Total	Offset	No. of Days	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)	Total	Offset	No. of days
	%	%	in.	in.		°	°	°	°	%	%	in.	in.	
Anuradhapura ..	75	95	1·21	+0·51	8	91·9	+0·6	71·8	+0·2	67	95	4·71	+0·56	7
Badulla ..	80	94	9·20	+6·03	18	82·5	+0·1	65·2	+0·9	75	95	5·32	+0·27	18
Batticaloa ..	80	90	12·15	+7·94	16	85·3	—0·1	76·4	+1·4	76	88	0·82	—2·65	8
Colombo ..	75	93	6·63	+4·03	11	86·9	—1·0	72·9	+1·1	73	90	5·54	+0·88	15
Diyatalawa ..	77	84	7·93	+5·56	16	79·7	+2·3	58·5	+0·3	74	91	4·17	—0·72	13
Galle ..	78	90	14·05	+10·76	15	86·0	—0·3	74·6	—0·5	76	90	6·67	+1·36	17
Hambantota ..	78	90	3·53	+2·07	14	87·2	+0·3	74·6	+0·3	76	90	5·28	+1·89	10
Jaffna ..	66	88	0·02	—1·44	1	88·9	+0·2	75·7	—0·1	66	86	0·26	—1·32	2
Kandy ..	69	89	6·16	+3·77	13	87·4	—0·5	67·5	+0·4	64	90	6·86	+1·44	14
Kankesanturai ..	74	88	0·10	—0·98	2	89·0	—	75·1	—	68	91	0	—1·47	0
Kurunegala ..	67	95	1·51	—0·48	6	92·9	+0·3	71·3	—0·8	62	95	9·02	+2·74	11
Mannar ..	72	84	0·34	—1·36	4	88·7	—0·6	76·3	+1·0	69	86	0·30	—1·54	5
Nuwara Eliya ..	75	84	6·81	—4·82	17	71·4	+0·5	47·8	+1·3	75	90	4·00	—0·09	14
Puttalam ..	72	93	1·45	+0·08	6	91·2	+1·3	72·8	—0·1	67	90	3·82	+0·74	6
Ratmalana ..	70	88	7·91	+4·55	14	88·1	—	74·0	—	67	86	3·26	—3·22	15
Ratnapura ..	75	95	11·32	+6·02	19	93·0	+0·9	72·3	—0·2	72	95	8·40	—1·98	22
Talawakele ..	72	79	5·47	+3·50	12	75·5	—2·4	56·1	+0·8	71	82	4·24	—0·38	15
Trincomalee ..	76	82	6·33	+3·68	10	87·4	+1·9	78·1	+1·6	71	84	0·03	—2·27	1

GOVERNMENT NOTIFICATIONS

TEA RESEARCH (AMENDMENT) ACT, No. 20 OF 1955

L. D.—O. 4/55.

Chapter 301, Vol. VI, page 441.

AN ACT TO AMEND THE TEA RESEARCH ORDINANCE

[Date of Assent: April 14, 1955]

BE it enacted by the Queen's Most Excellent Majesty, by and with the advice and consent of the Senate and the House of Representatives of Ceylon in this present Parliament assembled, and by the authority of the same, as follows:—

Short title.

1. This Act may be cited as the Tea Research (Amendment) Act, No. 20 of 1955.

Amendment of section 5 of Chapter 301.

2. Section 5 of the Tea Research Ordinance, as amended by the Proclamation published in *Gazette Extraordinary* No. 9,773 of September 24, 1947, by Act No. 24 of 1948 and by Act No. 51 of 1953, is hereby further amended in sub-section (1) of that section as follows:—

(1) in paragraph (*a*) of that sub-section, by the addition, at the end of that paragraph, of the following:—

"The Chairman of the Low-country Products Association of Ceylon."; and

(2) in paragraph (*b*) of that sub-section—

(*a*) by the substitution, for the words "One member nominated by the Minister to represent the small holders.", of the words "Two persons nominated by the Minister to represent the small holders.", and

(*b*) by the addition, at the end of that paragraph, of the following:—

"One member of the House of Representatives nominated by the Minister."

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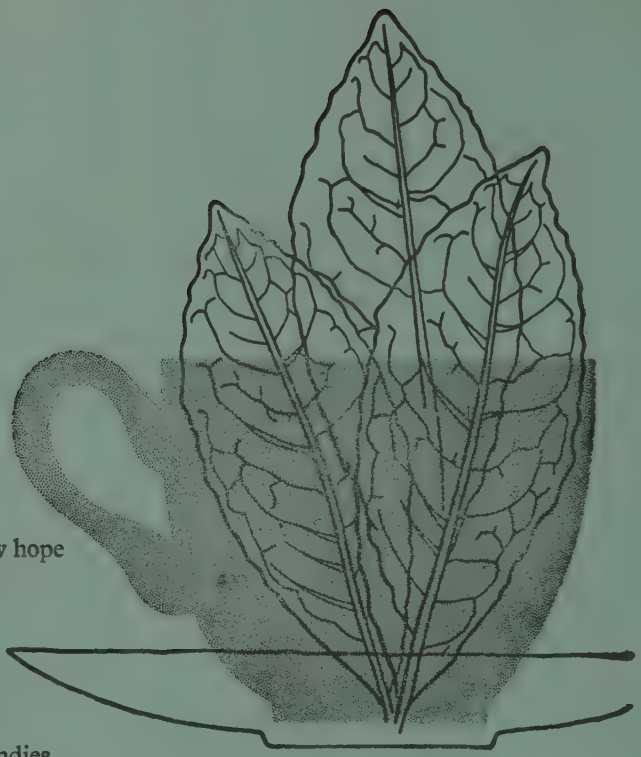

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Vol. CXI. No. 3

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TROPICAL AGRICULTURIST

Volume CXI July - September, 1955 Number 3

Published Quarterly By
DEPARTMENT OF AGRICULTURE
PERADENIYA, CEYLON

Subscription Rates

(*Inclusive of Postage*)

	Annual	*Single copy*
Local	Rs. 5·00	1·50
India, Burma and Pakistan	Rs. 6·50	2·00
Abroad	Rs. 8·00	2·50

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Back Cover	Rs. 40·00	50·00
Inside Back	Rs. 35·00	40·00
Inside Front	Rs. 35·00	40·00

All correspondence and payments should be addressed to AGRICULTURAL OFFICER (PUBLICITY SECTION) DEPARTMENT OF AGRICULTURE, PERADENIYA, CEYLON.

Registered as a newspaper in Ceylon.

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EDITORIAL

Agricultural Education in Ceylon

AGRICULTURAL EDUCATION of the vocational type, as distinct from the teaching of agriculture at University level or in primary and secondary schools of the Education Department as a subject in the curriculum, is one of the important functions assigned by Government to the Department of Agriculture. Consequently, during the last two decades in particular, this activity has formed an important feature of its work. The history of vocational agricultural education in the Island, however, dates back to as early as 1884 when a School of Agriculture was established in Colombo by H. W. Green, then Director of Public Instruction, with the approval of Government. The aims of the School were three-fold, viz., to create a class of trained landed proprietors, to equip young men for posts of Estate Superintendent, and to train teachers to give instruction in agriculture in village schools. Unfortunately, though the objectives of the scheme were most praiseworthy, the results were disappointing for a number of reasons but chiefly because of the unsuitable selection of site and the curriculum not being sufficiently practical. The School was, therefore, closed down in 1901. Its most noted protagonist was C. Drieberg, Superintendent from 1889 till its closure. Whatever may have been the reasons for the failure of the enterprise, it certainly served an important need during this period and was responsible, in one way or another, for the stimulation of agricultural development in the country and, ultimately, the creation of an Agricultural Department which, however, came into being only in 1912. Among the products of this School were two prominent Ceylon agriculturists, Mr. W. A. de Silva and Gate Mudaliyar A. E. Rajapakse.

Drieberg was an ardent believer in agricultural education and it was largely through his inspiration and efforts that the School of Tropical Agriculture at Peradeniya was founded in 1916 during the directorship of the late Sir Frank Stockdale. This School of Agriculture has in the course of its 40 years of existence undergone various changes in regard to its name, scope, and functions, but despite these vicissitudes, it has proved to be a valuable training ground centre for over 1,200 students in agriculture, both theoretical and practical, when the popular trend was heavily weighted in favour of the academic and professional type of education for our young men. In the history of this Island this School will stand out as a beacon of light which, through the agency of its alumni, contributed to the agricultural development of the country during the later Colonial era, through the various stages of self-government, and since Independence.

In the School of Agriculture at Peradeniya, students with the Senior School Certificate entrance qualification are given a two-year course of training in practical and theoretical agriculture in English. The course comprises all branches of agricultural science, viz., Agriculture, Horticulture, Animal Husbandry, Agricultural Chemistry, Agricultural Botany, Veterinary Science, Diseases and Pest Control, Farm Accounts and Agricultural Engineering. The object of the School is to equip

its students for practical agricultural avocations whether as estate proprietors, estate superintendents, agricultural instructors, food production officers, technical assistants, &c.

In order, however, to satisfy the pressing need for practical training in agriculture for rural youth and to promote the " back to the land " campaign which was to play a vital part in the national renaissance, the Department of Agriculture established a number of Farm Schools in various parts of the country where practical agricultural training with the minimum of theoretical knowledge is given in the national languages to sons of farmers and others who are most likely to profit by it. The course of study is of one year's duration and in addition to the main agricultural subjects, viz., agriculture, animal husbandry, horticulture, poultry and bee-keeping, include carpentry, smithy, masonry and one or two industrial subjects such as rattan weaving, toy-making, pottery, brick-making and coir rope making. There are 10 such practical schools for boys at present in the various Provinces and these are situated on Government farms where the types of agriculture best suited for the area are investigated and demonstrated. Over 350 students are turned out of these schools annually and while many of them have found employment as agricultural demonstrators and overseers, a large number have gone back to their lands and adopted the improved methods of cultivation which they learnt during the period of there training.

It was not long, however, before Government realised that educated women had to play an important part in the rural environment of this country. Accordingly, the late Mr. D. S. Senanayake when Minister of Agriculture and Lands with remarkable foresight started in 1945 a small school at Peradeniya for training village girls in agricultural pursuits which would be of use to them later on in life. The subjects of study included, besides gardening, dairying and poultry, such others as cookery, home management, sewing and first-aid in order to enable them to become more useful women in their homes and villages. The success attending this enterprise was so striking that a greatly enlarged school was established soon after at Walpita in the Western Province, where up to a hundred girls are given an year's course in agriculture and home management in the Sinhalese medium. Meanwhile the Girls' School at Kundasale which was to be on a par with the Boys' School of Agriculture at Peradeniya was started. The main object of this school was to train women in agriculture and rural home-management and thereby to enable them to engage in occupations relating to these subjects or to teach them to their less-favoured sisters. It is expected that the training will enable these students to be better housewives in a rural environment and to take a lead in the social advancement of the village communities around their homes. The courses are of two years duration and have until now been in English. Two other practical schools for girls on the Walpita model, but smaller, have been opened in the Northern and Southern Provinces respectively.

All the schools to which reference has been made are residential and while tuition and lodging are free, the pupils at Peradeniya and Kundasale have to pay for their board. Students at the other schools, whether for boys or girls, receive a daily allowance which enables them to meet the cost of food and other essentials. It is the intention of Government to establish one practical residential school for boys

and one for girls in each of the Provinces and provision has accordingly been made for this item in its Six Year Programme. It would thus be possible in due course to train annually about a thousand students in practical agriculture and rural home management, who should make a valuable contribution towards the improvement of the standard of agriculture and the economic conditions of the people of the Island.

A recent departure from the established policy in regard to agricultural education is the proposal of the Hon'ble the Minister of Agriculture and Food, since approved by Government, to establish a large number of day farm schools in different parts of the Island. In these schools village boys and girls over 14 years of age will be given a practical course of training in agricultural and rural home-management subjects as well as in certain cottage industries which may well be adopted in their home areas. The courses will be conducted in either Sinhalese or Tamil according to the location of the school. A start is to be made very shortly with the establishment of a day school for village girls at Kundasale. This new policy should result in a considerably larger number of rural students being trained in practical agricultural pursuits than would have been possible had only the practical residential schools been in operation. This policy is, therefore, a step in the right direction and should, in due course, bear fruit in abundance.

It is from the trainees of these residential and day farm schools that the country can hope to recruit colonists for our new land development schemes who could, with their wider outlook and training in improved agricultural practices, form the vanguard in the drive for increased food production. A natural development following the training of youth in practical agricultural pursuits is their settlement on the land. Government has accordingly started a pilot scheme at Kilinochchi in the Northern Province where 800 acres of irrigable land have been alienated to 250 educated landless young men who have passed through our practical farm schools or been given a special course of training in practical agriculture in order to fit them to make a success of their enterprise. The scheme is under the guidance and supervision of the Revenue Officer of the Province and Extension Officers of this Department. Government is very sympathetic in regard to the settlement of educated youth on the land, and other schemes similar to the one mentioned are being contemplated, both in respect of irrigable land as well as high land.

In addition to the types of agricultural training enumerated in the foregoing paragraphs, the Department has formulated proposals for the training of dairymen, poultrymen, gardeners, tractor drivers, &c., in the practical aspects of their respective subjects. It is thus hoped to turn out every year an increasing number of men and women qualified in various branches of agriculture, and thereby to promote the intensification of crop and animal husbandry in different parts of the country.

The question of University and school education in agriculture is advisedly not being referred to in this commentary on agricultural education in the Island as it lies outside the purview of this Department. But in view of the close relationship that should exist between agricultural training at University level, the two levels with which this Department is concerned, and in schools of the Education Department, it is hoped that the time will not be distant when the three authorities

would work in co-operation and frame an integrated scheme of agricultural and veterinary education for the training of boys and girls, and young men and women in various phases of this vital branch of our economy. Some liaison is already being effected between the Department and the University in regard to the planning and execution of the work of the Experiment Station, Peradeniya on which students from the University and the School of Agriculture are trained, by a Committee of representatives of both institutions. The results of this joint effort have been so encouraging that one could justifiably hope for an extension of this liaison in all other fields of agricultural educational effort, if only the opportunity for doing so was provided. The appointment of a Government Committee or Commission under an experienced agricultural education expert to examine and report on this question should prove of the greatest benefit to the country in this field of endeavour.

I am pleased to announce that The Rockefeller Foundation has made available a sum of $5,000 which will be utilised by them for the purchase of supplies and equipment to the laboratory of the Chemical Division of this Department. The Ceylon Government has accepted the offer and thanks the Foundation for this generous gift.

A. W. R. JOACHIM,
Director of Agriculture.

The Soils of Ceylon

Dr. A. W. R. JOACHIM

This paper was the Presidential Address to the Agriculture and Forestry Section of the 1st Sessions of Ceylon Association of Science held in October, 1945. It is now reproduced, with minor amendments and additions, because of its interest to readers of this Journal and students of agriculture and the allied sciences.

Brief Historical Review

A SURVEY of the literature reveals that the soils of Ceylon were the subject of observation from the morphological, geological, and vegetational aspects from early British times, but it was only during the coffee days that the systematic examination of Ceylon soils was first undertaken (1, 2). The more recent contributions of value to our knowledge of the subject are those of Bamber (3) on the tea soils of the Island and of Bruce (4, 5) on the paddy and forest soils. Soil analyses had, however, until comparatively recently, as their immediate objectives the determination of the physical constitution and nutrient status of the soils according to methods then in vogue. The modern study of soils lays emphasis on the genesis of soil, its relation to environmental factors, its profile character and the nature of its clay complex. Thus only has it been possible to establish some rational system of soil classification. Up to about 1935 but little had been done on the fundamental study and classification of Ceylon soils on these lines, though Schokalsky (6) had attempted a classification of our soils in conformity with well-recognized world groups from a knowledge of the literature then available. It was in 1935 that a systematic investigation of the soils of the Island on a pedological basis was started and the results of these studies have been published in a series of 20 papers by my assistants, Messrs. S. Kandiah and D. G. Panditesekera and myself in the *Tropical Agriculturist*.

In this paper I shall endeavour to present a summary of our knowledge of the subject as revealed by these studies, with special reference to the scheme of classification proposed. A provisional soil map of the Island on the basis of this classification is furnished. Simultaneously with the fundamental study of the soils of the Island, soil surveys of areas proposed for development as colonization schemes under the new land policy of Government were conducted with the object of ascertaining the suitability of each area or any part of it for development, the types of soil comprising it and their distribution, and the nature of the crops suited to each type. These development surveys have been of considerable value in extending our knowledge of the types of soil occurring within the major soil groups of the Island already identified and in furnishing data on the agricultural potentialities of these soils. As this aspect of our

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Colour plates of representative soil profiles of Ceylon will be published in a forthcoming issue of the *Tropical Agriculturist*

soil work is of a more practical character, I do not propose to dilate further on it. It would suffice to state that no fewer than 98 of these reconnaissance soil surveys have been carried out up to 1945.

The Soils of Ceylon and the Factors Governing their Character

The chief factors influencing the development and character of local soils are climate, nature of parent rock, vegetation and topography.

Climate is undoubtedly the predominant characterizing factor in the case of the majority of our soils. The high temperatures and heavy precipitations alternating with periods of dry weather, which are experienced over a large part of the Island, are eminently favourable for chemical weathering and the development of laterite (*cabook*) or lateritic soils where the nature of the parent rock material permits. In the process of laterisation the alkaline bases are leached out in combination with a part of the silica as soluble silicates, leaving a residual material considerably richer in the hydrated oxides of aluminium and iron than the original rock. The more advanced the laterisation process, the higher is the proportion of sesquioxides (alumina and iron oxides) in the soil and, more particularly, the clay complex. It is not often, however, that pure laterite soils are found in Ceylon, the great majority of the coloured soils being of the lateritic type. This is all to the good, as laterite soils are generally infertile while those of the lateritic type are of fair agricultural value. Under other conditions, for example when the rainfall is deficient or the drainage impeded, as in paddy soils or the geological material unsuitable for laterisation, as in the case of the Jaffna limestone, the tendency is for the weathering to be of the kaolinitic or montmorillonitic type. Under these conditions the proportion of silica to sesquioxides in the clay complex is generally higher than in lateritic soils, the clay largely consisting of hydrated alumino and ferro silicates, and the soils formed are of potentially greater agricultural value than the latter.

Climate also determines, to a large degree, the organic status of our soils. Over the greater part of the Island conditions are more favourable for the decomposition of organic matter than its accumulation, temperatures being much above the 25°C critical limit found by Mohr (7) in Java to be necessary for organic matter conservation. Our unirrigated cultivated soils are, therefore, generally poor in organic matter, frequently containing less than 2 per cent. of this constituent, the exceptions being the soils of virgin forests, grassland areas and fernlands. In the soils of the two latter, the organic matter content occasionally rises to 10 per cent. In these areas one or more of the following factors favourable for humus accumulation operate: low temperatures, overmoist soil conditions, a suitable type of vegetation—grass being ideal for the purpose owing to its fibrous root system. Under anacrobic conditions, as in wet paddy soils, the organic matter contents are higher than in adjacent high land.

Geology as a soil-characterizing agent is best exemplified in the case of the Jaffna soils associated with limestone parent material. The uniform, free-draining, deep red soils, similar to the *terra rossa* of Mediterranean regions, to

which these limestone rocks give rise, are independent of climatic influences. The nature of the geological material has also, to a large degree, determined the character of certain soils types in the low country where Pleistocene plateau deposits, first described by Wayland (9), have been reported to occur. These are the red and brown sandy soils of the Western and North-Western Provinces and the white cinnamon soils. There is also evidence all over the dry zone, and particularly where the dome-like ridges ("turtle backs" in Wayland's phraseology) of red and brown loams occur, that the upper horizon of these soils is identifiable with the red earth stratum of the Pleistocene deposits.

From the standpoint of the soil scientist the crystalline rocks of Ceylon, whether gneissic or igneous, are of significance only in so far as they are geologically basic or acidic. The acidic members of either group, like the granites or granulites, generally give rise to light coloured and textured soils, poor in lime, but likely to be rich in potash. Soils derived from basic rocks like the norites, are darker red in colour and generally heavier in texture, while in regard to plant food constituents they tend to be rich in lime and poor in potash. The actual composition of the soil will, however, depend on the kind of weathering to which the rock from which it has been derived was subjected, and the subsequent pedogenic (soil-forming) processes it has undergone.

The influence of vegetation on soil type in Ceylon is clearly seen in the *patanas* (grasslands) of the Central and Uva Provinces and the *kekillas* (fernlands) of Sabaragamuwa. Here surface soils of variable depth, rich in humic material, overlie yellow or reddish yellow laterite and lateritic loams. The origin of these patanas and fernlands cheek by jowl with forest vegetation on the same hill-slope was investigated by us from the soil standpoint. The conclusions arrived at from this study point to the fact that these plant communities are an ecological succession to the forest climax, the transformation having been effected by the periodical burning of the secondary vegetation for grazing. In the case of the wet patanas and fernlands, the strongly acid soil conditions induced by the vegetation and almost continuous rainfall contribute to the elimination of all but a few tree species. In the dry patana area intense precipitation during the rainy season causing severe soil erosion, a prolonged dry season when soil moisture is reduced to limits below the minimum required for the growth of shrubs and trees, and strong desiccating winds are additional factors responsible for the permanence of this vegetation type. Soil data show that while the surface horizons reflect the effect of the vegetation on soil composition and texture, the C-horizons (sub-soils) of both grass or fernland and adjacent forest land are very similar physically as well as chemically. The drainage of the patana sub-soil tends, however, to be defective.

The soils of the highlands and of the paddy areas furnish the best examples of the effect of topography on the character of local soils. In the former, severe erosion caused by the heavy and intense rainfall has depleted the soils, for the most part, of the valuable surface soil with its accumulation of humus, colloidal material and easily-available plant fertilizing constituents. In the low-lying paddy areas, this wash

from the hills is deposited. In these paddy soils the influence of water movement as governed by topography is seen to advantage. Typical paddy soils are generally, for the greater period of the year, either submerged under water or poorly drained, the water table being at or near the surface. As a result the soils are of the characteristic *gley* type, the lower layers being bluish grey to dark grey in colour and mottled brown by hydrated iron oxides. These gley soils constitute the lowest members of series or *catenas* of soils beginning with the well-drained reddish or yellowish soils of the upper slopes followed by the moderately-drained reddish brown and brown soils of the middle slopes and the grey brown and grey imperfectly drained soils of the lower slopes. Under well-drained conditions, these paddy soils make quite good arable loams. Where the soils are water-logged, however, peat-like deposits such as those at Muthurajawela in the Negombo District and in the gemming areas of the Island, accumulate occasionally to depths of 10 feet or more. Other examples of soils in which topography determines their nature are the alluvil loams and silts.

Classification of Ceylon Soils

Based on these edaphic factors, the soils of Ceylon may be classified into the following major groups and series. The rough distribution of these soil types is shown in the provisional soil map furnished, and their analytical data indicated in the table.

(1) Zonal soils in which climate is the dominant soil-characterizing factor. These include :—

(i) the reddish to yellowish laterite soils and lateritic loams formed under conditions of high rainfall and temperatures and derived from igneous and gneissic rocks ;

(ii) the red, reddish brown, and dark grey lateritic and non-lateritic loams of the "dry zone" of the Island with an annual rainfall of 40-75 inches, also derived from igneous and gneissic rocks.

(2) Intrazonal soils associated with limestone. They comprise :

(i) the brick red loams (*terra rossa*) derived from Miocene limestone in the North and North-West of the Island

(ii) the grey calcareous loams (*rendzinas*) also derived from Miocene limestone

(iii) soils similar to the black cotton soils of India frequently associated with Miocene or dolomitic limestone

(iv) the chocolate red loams associated with or derived from crystalline limestone, mainly dolomite

(v) a small area of red loams over sandstone associated with Jurassic limestone

(3) Soils derived from Pleistocene and sub-recent deposits :

(i) the red and brown sandy loams

(ii) the bleached white sands (cinnamon soils) and the coastal sands

(4) The humic soils overlying reddish yellow laterite and lateritic loams and clays, including :

(i) the wet grassland (*patana*) soils

(ii) the dry grassland (*patana*) soils
(iii) the fernland (*kekilla*) soils
(iv) the low-lying peaty soils and *deniya* soils

(5) Azonal soils :

(i) alluvial silts and loams
(ii) the paddy soils

Small extents of intrazonal alkali soils exist in isolated patches in the semi-arid dry zone of the Island.

The following is a brief description of these soil groups and series :—

1. (i) The laterite and lateritic soils. In Ceylon true laterite, the material used for bricks and known locally as cabook, occurs mainly in the wet low country zone. The silica/alumina ratio does not always satisfy the standards laid down for laterite soils (<1.33). The material, which shows a characteristic reticulated structure, is of variable depth and is usually overlain by a gravelly loam. The reddish yellow loams which morphologically should be classed as laterite soils are again mainly lateritic in nature on the basis of their silica/alumina ratio. The yellow soils formed under almost-continuously moist conditions and overlain by humic loams, and those developed under extremely heavy rainfall conditions (over 125 in. per annum) do, however, come within the category of laterite soils accordingly to Martin & Doyne's classification. The reddish loams are mainly of the lateritic type. With the exception of typical laterites, these soils are fairly deep loams of varying texture, containing ironstone nodules and small boulders in varied proportions. They are generally well-drained, especially the reddish loams, hard but friable when dry, acid in reaction, extremely poor in bases and fairly well supplied with nitrogen in their surface horizons. They are low in total and exchangeable potassium and very low in available phosphate. The vegetation is generally forest and high jungle except in the wet patana (grassland) zone. These soils are cultivated with permanent crops—tea, rubber and coconuts generally.

(ii) (*a*) The dry zone red and reddish brown lateritic and non-lateritic soils are well-drained, friable loams of fair depth. The reddish brown loams are frequently non-lateritic in nature. They overlie gravelly loams grading down to decomposing rock. Slightly acid, alkali or neutral in reaction, they have fair but variable nitrogen and exchangeable base contents. The heavier soils are well supplied with total and exchangeable potash. The natural vegetation of these soils is high and medium jungle. They are best suited for arable crops and, where irrigation is feasible, for paddy. Fruit crops are also grown on them where the rainfall conditions are satisfactory.

(ii) (*b*) The dark grey loams occur in low-lying locations. They are of variable depth and almost invariably non-lateritic in nature. Their drainage is imperfect. They are generally heavier in texture than the red and brown loams, richer in plant nutrients than the latter, and alkaline in reaction. The phosphate availability of soils of group (ii) varies a great deal and is high in some types and low in many others. Low jungle is their natural vegetation, but occasionally what are known locally as *damanas* or parklands occur on them. They are typical paddy soils.

Groups (ii) (*a*) and (ii) (*b*) above form the components of a typical dry zone catenary complex.

In certain localities in the dry zone, shallow grey brown light sandy loams derived from acid feispathic gneiss occur. These overlie decomposing rock and are of poor nutrient status, except in regard to potash. They are non-lateritic in nature. Their natural vegetation is low jungle and scrub.

2. (i) The brick red loams of the North and North-Western part of the Island derived from Miocene limestone are uniform in texture, colour, &c., down to parent rock, which occurs at a depth of from 1 to 30 feet from the surface. These soils are very well drained, rich in bases including potassium, fairly well supplied with phosphates, slightly alkaline in reaction, poor in nitrogen and organic matter, and non-lateritic in nature. Annual crops thrive well on them when manured with bulky organics (4). These appear to be typical *terra rossa* soils. The natural vegetation is scrub and palmyrah palm.

(ii) The greyish white and grey loams also derived from Miocene limestone. They are similar to the *rendzinas* or chalk soils of Britain and are of shallow depth. They have fairly high reserves of calcium carbonate, are non-lateritic in nature, well supplied with bases, but are poor in nitrogen. They are mainly suited for paddy and arable crops. Their natural vegetation is also scrub and palmyrah palm.

(iii) The chocolate red loams derived from or associated with crystalline limestone, mainly dolomite, are heavy loams of varying depth, but imperfectly drained owing to their relatively high magnesium contents. Occasionally they are associated with a high proportion of ironstone gravel. They have relatively high available potash contents but are poor in phosphates. In reaction they are neutral or slightly alkaline. They are non-lateritic in type. The natural vegetation is high jungle. This soil is suited for annual crops and for tree crops with drainage.

(iv) Soils similar to the black cotton soils of India frequently associated with Miocene and crystalline limestone occur in the North-Western part of the Island and typically near Tunukkai with an annual rainfall of about 40 in. The soils are heavy loams poor in organic matter and nitrogen, rich in bases, and alkaline in reaction. Nodules of limestone occur within a foot of the surface. The natural vegetation is zerophytic low scrub. These soils are not dissimilar to those of group 1 (ii) (*b*) above.

(v) Red loams over gravelly loams derived from Jurassic limestone occur in a small extent of land at Tabbowa near Puttalam. Nodules of limestone are found in the lower strata. This soil type is similar to the red Miocene soil.

3. (i) The red and brown sandy loams, the typical coconut soils, are generally deep, well-drained light loams and sands with no apparent profile change, except that the surface soil is slightly darker in colour owing to its higher organic matter content. These soils occasionally overlie gravelly loams. Though poor in all plant nutrients, particularly potash, they give excellent crops of coconuts when manured. They are non-lateritic in type.

(ii) The white cinnamon soil is a bleached sand derived from (i) and

occurring in areas of higher rainfall. It is extremely poor in nutrients and is characterized by a dark grey clay-humic illuvial pan at a depth of 5 feet or so. Drainage is accordingly defective, and for successful growth of crops other than cinnamon, e.g., coconuts, drains have to be cut through this pan. This soil type is the nearest approach to a ground water podzol, the only difference being the absence of the surface organic layer. The coastal sands are similar to (ii) chemically, but lack the illuvial horizon.

4. (i) The typical grassland (*patana*) soils may be divided into two types: (i) the "wet" patanas which occur in areas of high annual precipitation, evenly distributed, and at elevations of 4,000 to 6,000 feet; (ii) the "dry" patanas with a lower annual precipitation and a marked wet and dry season. They occur at elevations of about 3,000-4,000 feet. The soils of both types are derived from crystalline rocks. The chief feature of the wet patana soil is a dark brown to black acid humic surface horizon of depth varying from 1 to 3 feet or more, overlying a gravelly layer, superimposed on a mottled reddish-yellow laterite loam. These soils are strongly acid in reaction, extremely poor in available calcium but moderately well supplied with potassium, deficient in phosphates, but rich in organic matter and nitrogen in the A & B horizons. Drainage is imperfect owing to the compact nature of the sub-soil. Earth slips occur frequently. The wet patanas occur side by side with low jungle of a characteristic type. Tea is their main cultivated crop. This soil may be classified as a mountain peat.

(ii) The dry *patanas* have only a shallow humic surface horizon which overlies in turn a reddish to purplish loam of variable depth and rock in varying stages of decomposition. The soils are lateritic in type, moderately acid in reaction, poor in bases and phosphoric acid, and have much less nitrogen and organic matter than those of the wet patanas. This type may be designated a tropical mountain steppe soil.

(iii) The fernland (*kekilla*) soils are also acid humic soils occurring in regions of high rainfall and rain forest vegetation. The humic layer does not generally exceed 1 foot in depth. It overlies yellowish laterite and lateritic gravelly loams. The soils are poor in mineral nutrients and phosphorus. The fern is a secondary growth arising from the clearing of the jungle and periodical burning of the succeeding vegetation. These soils are best suited for rubber and tea.

(iv) The low-lying, ill-drained peaty soils are of variable depth from 1 to 4 feet and over. They overlie loams and clays, not infrequently kaolin. Their organic matter contents often exceed 25 per cent. The surface soils are acid in reaction but have fairly high exchangeable base contents and are lateritic in type. These soils are only suitable for paddy cultivation and may be classified as half-bog soils. Occasionally they are inundated with salt water from adjacent lagoons. A variant of this soil type is a low-lying, ill drained, humic sand overlying clay and known locally as a *deniya* soil. It is an acid soil poor in bases and lateritic in nature. The alumina content of the clay fraction is very high.

5. (i) & (ii) The reddish brown, grey brown and yellowish brown alluvial

silts, loams and clays are essentially paddy soils by virtue of their location. They infrequently exhibit a gley horizon being intermittently water-logged. The paddy soils vary markedly in texture from light loams to clays and show equally marked variations in chemical nature. They are generally richer in plant nutrients than the adjacent highland soils. Most of them are in short supply of phosphorus and respond well to applications of this fertilizer.

Reference may here be made to the magnesium content of our soils as instances of deficiency of this element are occasionally encountered. Magnesium is deficient in sandy and laterite soils and occasionally in some lateritic types (12).

The Physical and Physico-Chemical Characteristics of Ceylon Soils

The soils of the dry zone of the Island are lateritic or non-lateritic in nature. They generally have high exchangeable base capacities when of high or medium clay content, low ultimate pH values, and frequently high base saturation percentages. They are thus neutral or moderately acid in reaction and fairly rich in available mineral nutrients. Their dispersion ratios are relatively high. They, therefore, tend to be easily erodible. Some of them are not friable when dry, and, when wet, are sticky and difficultly permeable to water. They would need careful and timely cultivation if a fine soil tilth is desired.

The soils of the wet zone are invariably of the lateritic or laterite type. As compared with the dry zone soils they have generally lower exchangeable base capacities and are hence of lower mineral nutrient status. They are less saturated with bases and consequently more acid in reaction. Being more permeable to and less dispersible in water they drain better and are not so erodible. They are also more friable when dry. They are, therefore, more amenable to cultivation under varying moisture conditions than the dry zone soils.

KEY TO SOIL MAP

1. Soils derived from Igneous & Gneissic Rocks
   - (i) Laterite (cabook) & lateritic reddish yellow loams & gravelly loams of ultra-wet zone
   - (ii) Reddish to yellowish red lateritic loams of wet zone
   - (iii) Lateritic & non-lateritic red, reddish brown and dark grey loams of dry zone
   - (iv) Non-lateritic grey brown sandy loams
2. Soils associated with Limestone
   - (i) Red loams derived from Miocene limestone
   - (ii) Grey loams derived from Miocene limestone
   - (iii) Black heavy loams associated with Miocene & crystalline limestone
   - (iv) Brownish red loams associated with crystalline limestone (mainly dolomite)
   - (v) Red loams associated with Jurassic limestone
3. Humic Soils overlying Yellowish to Reddish Laterite and Lateritic Loams and White Sands
   - (i) Grassland (*patana*) soils (wet and dry)
   - (ii) Fernland soils (*kekilla*) soils
   - (iii) Low-lying peaty soils (paddy soils, &c.)
4. Soils derived from Pleistocene & Sub-Recent Deposits
   - (i) Red and brown sandy soils (typical coconut soils) over gravel occasionally
   - (ii) White sands (cinnamon soils, &c.)
5. Recent Alluvial Deposits, etc.
   - (i) Reddish brown, grey brown & yellowish brown loams & clays
   - (ii) Existing paddy (*gley* soils)

PROVISIONAL SOIL MAP
OF
CEYLON. 1945
KEY
I
II
III
IV
V
1
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Prepared by
Dr. A.W.R. Joachim

Analyses of Ceylon Soils

Soil Groups and Series	Location	Rainfall inches	Geology	Vegetation	Horizon	Inches	Stone and Gravel %	Clay %	Carbon %	Nitrogen %	Exchange-Bases mgm. equiv. %	Clay Fraction Silica/Alumina Ratio (mol.)	pH
1. Red to Yellow Laterite, Lateritic and Non-lateritic Soils—													
(i) Ultra wet zone yellowish lateritic loam	Massena, Balangoda	Over 200	Charnockite	High jungle	A	0—12	20·0	42·4	2·51	0·197	0·8	1·40	5·0
					B	12—24	34·9	40·2	1·12	0·079	—	—	5·9
					C	24—36	22·1	38·7	0·73	0·047	0·5	1·38	6·4
(ii) Ultra wet zone yellowish red lateritic loam	Ambepussa	117	Charnockite	Coconuts and garden crops	A	0—10	10·2	43·2	1·82	0·158	3·2	1·40	6·1
					B	10—30	21·7	55·0	0·94	0·099	1·8	1·47	6·6
					C	30—60	16·6	57·7	0·48	0·065	0·5	1·39	5·1
(iii) Wet zone yellowish red lateritic loam	Peradeniya	94	Khondalite	Mana grass and tea	A	0—9	nil	42·7	0·97	0·128	5·8	1·59	5·1
(iv) Dry zone reddish brown non-lateritic loam	Anuradhapura	55	Gneiss	Dry zone crops and fruits	A	0—6	7·0	14·6	2·03	0·130	17·1	2·22	7·7
					C	6—28	14·3	20·8	0·63	0·073	11·1	—	7·7
					C	28—36	7·9	33·4	0·34	0·066	14·2	—	7·8
(v) Dry zone red lateritic loam	Sigiriya	76	Bintenne gneiss	Low jungle	A	0—10	20·2	24·2	1·97	0·159	14·6	1·72	7·1
					B	10—44	67·3	41·1	0·44	0·048	10·0	—	6·9
					C	44 >	8·5	28·9	0·32	0·031	15·3	—	7·2
(vi) Semi-dry zone dark grey non-lateritic loam	Minneriya	79	Recent over felsphatic gneiss	Medium jungle	A	0—6	6·8	20·7	1·39	0·103	12·3	4·68	7·0
(vii) Semi-dry zone grey brown sandy loam	Unichchai	80	Acid gneiss	Scrub and low jungle	A	0—9	nil	5·8	0·74	0·078	1·2	—	5·9
2. Limestone Series—													
(i) Brick red loam	Tinnevely, Jaffna	50	Miocene limestone	Tobacco and garden crops	A	0—12	nil	26·2	0·45	0·057	9·9	1·93	8·0
					AC	12—48	1·9	41·7	0·33	0·052	11·2	—	7·8
(ii) Grey loam*	Delft Island	46	Miocene limestone	Pasture grass and dry grains	A	0—9	nil	17·2	0·80	0·094	—	2·78	8·4
					C	9—36	nil	21·9	0·45	0·050	—	—	8·4
(iii) Black loam	Tunukkai	40	Limestone over felsphatic gneiss	Scrub jungle	A	0—36	10·1	31·7	0·51	0·069	76·5	2·81	8·6
(iv) Chocolate red loam	Nalanda	85	Dolomitic limestone	Tobacco, citrus, &c.	A1	0—15	2·2	25·0	1·20	0·123	10·6	2·34	7·0
					A	15—30	4·2	32·8	0·66	0·076	9·1	—	6·9
					C	30—54	nil	43·9	0·51	0·073	8·4	—	6·9
(v) Brownish red loam	Tabbowa	46	Jurassic limestone	Coconuts	A	0—18	nil	26·9	1·32	0·112	15·6	3·26	7·1

Analyses of Ceylon Soils—(*contd.*)

Soil Groups and Series	Location	Rainfall inches	Geology	Vegetation	Horizon	Inches	Stone and Gravel %	Clay %	Carbon %	Nitrogen %	Exchange-Bases mgm. equiv. %	Clay Fraction Silica/Alumina Ratio (mol.)	pH
3. Humic Series													
(i) Wet grassland (patana)	Kandapola	98	Khondalite	Grass and rhododendrons	A1	0—14	0·6	22·6	6·32	0·371	0·4	0·75	5·3
					A2	14—25	4·3	32·5	3·93	0·245	0·4	0·77	5·7
					B	25—32	39·2	44·8	1·20	0·096	0·4	0·82	6·0
					C >	32	14·1	41·4	0·46	0·044	0·5	0·85	6·0
(ii) Dry grassland (patana)	Welimada	54	Khondalite	Grass, fruits and tea	A	0—8	8·5	30·6	2·78	0·199	2·5	1·64	6·3
					B	8—30	90·0	31·1	2·33	0·173	2·1	1·66	6·5
					C1	30—66	3·8	33·6	0·73	0·066	2·1	1·72	6·1
					C2 >	66	0·9	13·6	0·21	0·023	2·2	1·71	6·2
(iii) Fernland (kekilla)	Liniyawa	164	Charnockite	Ferns, &c.	A1	0—6	25·3	15·4	2·13	0·113	2·5	1·22	5·1
					A2	6—14	5·8	16·6	1·37	0·079	2·1	—	5·0
					C >	14	16·8	17·5	0·87	0·065	1·0	—	4·8
(iv) Peaty loam	Labuduwa	102	Recent cumulose	Paddy	A	0—9	nil	46·1	14·97	0·761	24·7	—	5·7
4. Pleistocene Plateau Deposit Series													
(i) Brownish red sand	Marawilla	65	Pleistocene deposits residual	Coconuts	A1	0—6	nil	5·2	0·42	0·064	1·7	2·02	6·5
					A2	6—18	nil	10·6	0·35	0·060	1·5	1·94	6·7
					C >	18	nil	13·1	0·22	0·050	1·1	—	6·8
(ii) White sand	Negombo	90	do.	Cinnamon and coconuts	A	0—60	nil	2·6	0·21	0·028	1·1	—	4·6
					B1	60—70	nil	5·6	0·64	0·047	1·2	—	4·8
					B2	70—83	nil	7·1	1·44	0·047	2·9	1·88	4·9
(iii) Reddish brown loam	Middeniya	67	do.	Fruits, citrus and rotation crops	A	0—36	nil	27·2	0·47	0·043	4·1	1·81	7·9
5. Recent Series—													
(i) Brown sandy loam	Manampitiya	70	Alluvial	High jungle and tobacco	A	0—5	nil	15·1	1·68	0·108	12·6	1·84	7·3
					C >	5	nil	10·3	1·09	0·060	8·1	—	7·1
(ii) Yellowish brown loam	Peradeniya	94	do.	Paddy	A	0—4	0·5	39·6	2·75	0·217	5·8	1·62	5·1
					B1	4—12	2·1	40·2	2·49	0·212	5·3	—	5·2
					B2	12—17	4·9	41·1	1·46	0·149	5·2	—	5·7
					C >	17	20·1	26·3	0·79	0·072	2·9	1·65	6·2
(iii) Dark grey clay loam	Tambalagam	75	Alluvial over biotite gneiss	Paddy	A	0—6	2·9	38·6	2·43	0·274	21·4	4·38	6·8
					C	6—12	3·0	35·0	2·21	0·268	23·7	—	7·1

* Contains 56·9 per cent. calcium carbonate.

References

1. HUGHES, T.—Ceylon Coffee Soils and Manures, 1897.

2. COCHRAN, M.—Ceylon Manual of Chemical Analyses, 1895.

3. BAMBER, M. K.—Report on Ceylon Tea-Soils, 1900.

4. BRUCE, A.—Forest Soils of Ceylon, *Dept. Agr. Ceylon,* Bull. No. 61.

5. BRUCE, A.—A Contribution to the Paddy Soils of Ceylon, *Dept. Agr. Ceylon,* Bull, No. 57.

6. SCHOKALSKY, Z. T.—Contributions to the Knowledge of the Soils of Asia. Chap. VI. Ceylon.

7. JOACHIM, A. W. R.—KANDIAH, S., and PANDITTESEKERA, D. G.—Studies on Ceylon Soils, *Trop. Agst.* Vol. 84, 85, 88, 89, 90, 92, 95, 96, 98, 103, 1935-54.

8. JOACHIM, A. W. R.—A Manual of Green Manuring, Chapter 1. The Principles of Green Manuring and their Application in Ceylon.

9. WAYLAND, E. J.—Stone Ages of Ceylon. *Spolia Zeylanica,* Vol. 11, 1915-21.

10. JOACHIM, A. W. R., and KANDIAH, S.—The Chemical and Physical Characteristics of the Soils of Adjacent Contrasting Vegetation Formations. *Trop. Agst.* Vol. 98, No. 1, 1942.

11. PONNAMPERUMA, F. N.—The Potash Status of Ceylon Soils. *Trop. Agst.* Vol. 108, 1952.

12. KANDIAH, S.—Evidence of Magnesium Deficiency in Ceylon Soils. *Trop. Agst.* Vol. 110, 1954.

Agriculture in the Central Division

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THE Central Division comprises of the three Revenue Districts of Kandy, Matale and Nuwara Eliya and covers an area of 2,290 square miles in extent with a population in 1953 of 1,366,596.

Physical Features

The central and southern parts of the Central Division are largely mountainous and contain the highest mountains of the Island. The northern and eastern parts of the Matale District gradually merge into the low-country central dry zone while the eastern section of the Division drops sharply into the eastern dry zone. The relief of the land is described as follows :—

> "By far the greater portion of the Central highlands of the Island fall within these two Provinces (Central and Uva). The main mass of mountains is in the southern portion of the Central Province where the altitude of the land is generally over 3,000 feet, rising to 7,360 feet (Adam's Peak) and 8,281 feet (Pidurutalagala). Another range of mountains lies north and east of Kandy; rising from the Dumbara Valley it reaches an elevation of over 6,000 feet in the Knuckles Group. This range runs northwards into the Matale District and divides the southern portion of that District into the developed area of Matale South on one side and the undeveloped area of Matale East on the other; running northwards again along the western boundary of Matale District is a lesser range of hills. The highest peak of this range is Etapola, 4,152 feet. Beyond these mountain ranges in Matale District, the land gradually slopes down to a plain which occupies a greater portion of Matale North and Matale East. Here and there large hills stand out from the plain. The mountain ranges of the Nuwara Eliya District are continued beyond its eastern boundaries to the Province of Uva". (i)

Both the Mahaveli-ganga and Kelani-ganga rise in the mountain regions of this Province. The Maskeliya-oya which falls into the Kelani-ganga rises in Adam's Peak. The many tributaries of the Mahaveli-ganga drain almost the entire Province and in the upper reaches, flow rapidly through rocky gorges and cataracts. The course of the Mahaveli-ganga is described as follows :—

> "Taking its source above Hatton, it flows northwards past Nawalapitiya and joined by the Kotmale-oya proceeds past Gampola, Peradeniya and Kandy; here it turns sharply eastwards into the Dumbara Valley and flowing eastwards for a considerable distance it reaches the western boundary of the Uva Province close to Minipe; thence it flows north into the plain of Bintenne, constituting from this point onwards the boundary between the Central Province and Uva until it reaches the Eastern

Province where it is joined by the Ambanganga, one of its largest tributaries. The Ambanganga itself rises in the mountains of Pata Dumbara and flows northwards through the Matale District until, a little beyond Nalanda, it turns in a north-easterly direction to flow through Matale East Division into the Eastern Province.

The other important tributaries of the Mahaveli-ganga in these two Provinces, apart from the Ambanganga are the Kotmale-oya mentioned earlier, the Gurugal-oya and the Ulhitiyawa-oya. The basin of the Mahaveli-ganga is thus comprised of almost the entirety of the Central Province and also a portion of Uva". (i)

Climate and Rainfall

Marked differences in climate are experienced in different parts of each of the three Revenue Districts of this Division. The two factors—variations in elevation and variations in the distribution of rainfall combine to produce a diversified climate. In the cool higher elevations the temperature varies from 58°—718° F., while in the warmer lowlands the temperature varies from 75°—85°F.

As the southern and western parts receive more than 20" of rain during the south-west monsoon they fall within the wet zone and the northern and eastern parts in the dry and semi-dry zones.

TABLE I

AVERAGES OF ANNUAL DISTRIBUTION AND MAXIMUM AND MINIMUM RAINFALL IN REPRESENTATIVE AREAS

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Kandy District														
Kandy	average *a*	6·35	2·30	5·80	6·50	7·59	8·85	7·33	5·69	6·70	10·75	11·02	8·47	86·88
	b	3·16	2·16	4·36	7·61	8·39	8·60	6·60	7·89	4·60	10·22	9·58	10·80	83·52
	Min.	·22	·04	1·29	4·60	·78	3·52	2·16	1·22	2·00	6·11	1·97	2·27	62·20
	Max.	10·40	3·01	8·95	15·20	27·49	14·56	14·75	28·41	10·00	16·00	14·15	18·63	107·61
Nawalapitiya	average *a*	3·78	12·78	6·85	10·95	13·86	—	20·13	14·94	15·48	20·60	13·40	8·01	155·41
	b	1·96	2·40	6·39	10·89	14·92	23·43	19·21	18·52	13·62	19·34	13·43	9·59	141·13
	Min.	0·00	·55	2·21	3·70	2·91	15·52	6·02	6·02	6·63	9·50	1·17	2·11	108·85
	Max.	7·83	7·47	15·70	16·47	52·91	33·98	29·60	33·75	18·44	29·77	27·66	21·47	215·98
Minipe	average *a*	10·89	6·61	8·22	1·79	3·28	0·00	0·32	0·98	0·94	3·95	2·98	9·39	76·99
	b	12·73	10·31	5·36	7·11	2·90	0·25	1·60	1·48	2·17	8·28	11·04	13·33	83·86
	Min.	1·71	0·00	0·80	0·00	0·00	0·00	0·00	0·00	0·00	3·23	1·19	8·63	41·83
	Max.	24·12	26·26	11·10	11·30	10·37	1·83	5·63	5·63	4·35	15·27	21·90	36·37	121·74
Madugoda	average *a*	21·93	7·30	6·50	8·50	5·39	2·61	3·24	2·78	4·60	12·00	15·23	20·05	110·09
	b	12·92	7·29	8·18	7·48	7·26	2·75	2·81	2·97	3·66	9·47	12·69	20·58	83·99
	Min.	2·25	0·00	1·20	0·00	0·67	0·36	0·21	0·30	0·00	0·00	5·43	5·18	64·13
	Max.	28·42	21·14	12·39	11·30	22·39	5·49	6·72	10·53	6·99	15·23	32·76	34·95	135·56
Matale District														
Matale	average *a*	8·21	2·62	4·50	6·81	6·42	6·32	5·05	4·16	5·21	11·94	11·39	8·70	81·23
	b	4·51	2·87	4·57	7·06	7·61	6·14	5·39	6·02	4·70	11·21	10·57	10·58	81·28
	Min.	0·47	0·00	0·60	3·15	0·62	4·12	2·05	1·20	1·16	5·24	1·58	4·29	60·31
	Max.	10·00	11·32	9·55	17·20	20·88	9·07	12·65	19·75	11·50	16·30	19·41	15·66	106·21
Elkaduwa	average *a*	9·50	3·07	6·07	8·60	8·88	8·57	7·80	6·09	7·67	15·49	14·31	12·00	108·26
	b	5·13	3·25	5·32	8·17	10·97	7·10	7·24	7·92	6·32	15·30	13·32	14·17	104·26
	Min.	0·35	0·15	1·26	3·80	0·28	3·81	2·36	0·42	1·38	8·87	3·16	4·90	89·06
	Max.	14·94	15·53	11·26	11·33	29·61	11·49	13·83	26·84	11·14	24·93	25·54	27·65	128·28
Pelwehera	average *a*	9·92	2·80	4·51	6·78	3·45	0·99	1·47	1·72	3·05	9·00	11·67	10·87	66·13
	b	4·84	1·72	3·03	5·46	2·22	0·73	0·83	2·53	0·76	7·38	8·40	11·84	50·10
	Min.	2·51	0·00	1·51	2·80	2·09	0·42	0·77	0·48	0·05	2·47	6·01	8·93	37·06
	Max.	8·92	2·96	5·84	7·50	2·35	1·69	0·94	4·59	1·18	9·98	10·23	14·62	57·53

TABLE 1—(*contd.*)

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Nuwara Eliya District														
Hanguranketa	average *a*	16·64	4·02	5·07	6·37	4·53	2·54	2·92	2·53	3·48	10·25	11·20	13·36	83·11
	b	10·01	7·35	6·26	7·39	6·81	2·26	1·86	2·23	3·03	9·31	12·28	15·74	74·63
	Min.	0·80	0·80	2·41	1·34	0·74	0·52	0·28	0·31	0·32	3·17	3·94	6·08	50·50
	Max.	23·36	24·63	15·12	11·98	24·37	5·20	3·86	5·64	8·08	16·05	30·71	36·19	109·07
Walapane	average *a*	20·16	5·51	5·16	5·72	5·29	0·48	0·98	2·28	2·24	8·18	12·74	18·49	98·13
	b	14·82	5·21	7·01	8·32	7·36	1·81	1·75	2·89	2·98	10·98	15·47	22·08	103·48
	Min.	4·48	0·80	2·68	1·80	1·00	0·47	0·68	0·16	0·06	5·05	8·23	11·22	69·12
	Max.	25·82	21·20	12·93	13·42	21·49	4·90	3·57	7·62	6·13	18·03	27·33	33·50	126·23
Ramboda	average *a*	9·17	2·55	5·57	7·74	12·92	18·67	20·18	14·03	13·66	15·28	13·15	10·19	143·11
	b	4·38	2·66	6·50	9·33	13·20	19·24	17·32	14·68	11·14	15·65	11·44	10·01	138·94
	Min.	0·04	0·07	1·97	4·55	3·25	8·80	5·98	3·91	4·63	8·83	3·41	3·07	97·98
	Max.	11·46	10·30	16·98	14·67	31·63	32·56	34·76	41·63	19·57	24·23	19·05	16·98	198·74

* Averages : (*a*) 1911–1940
(*b*) 1940–1950

Table I shows wide variations in rainfall at different elevations. It also shows striking differences in the rainfall between the high elevation wet and high elevation dry zone.

Agriculture in this Division is mainly under rainfed conditions. The very wide variations in the monthly rainfall, in some years, ranging from almost complete failure of rains to spectacular excesses over the average for the month, adversely affect agricultural activities connected with rice and other seasonal crops. And although perennial crops such as Tea, Rubber, Cacao, Coconuts and fruit trees survive these extreme variations, yet crop production is adversely affected and seasonal output becomes variable following on seasons of unusual weather conditions.

The acreage served by major Irrigation Schemes in this Division is 8181.3 acres and is very low compared to major schemes in other Divisions.

The acreage irrigated by construction of permanent, semi-permanent and seasonal dams across small water courses is 41,129.1 acres. Most of these streams, however, go dry in the absence of rain for even a fortnight. The extent of paddy land dependent on direct rainfall and perennial springs is 29,704 acres.

Population

The Central Division is second in point of population though sixth in point of size. According to the Census figures of 1953 the population of the Central Province has increased from 365.6 thousand comprising of 212.6 thousand males and 153.5 thousand females in 1871 to 1366.6 thousand comprising of 715.7 thousand males and 650.9 thousand females in 1953. Of this approximately 492,000 are Indian Tamils. The density increased from 82 per square mile in 1871 to 597 per square mile in 1953. The relative figures for each of the Revenue Districts are as follows :—

District	*All Persons*	*Males*	*Females*
Kandy	840,448	439,115	401,333
Matale	201,126	107,700	93,426
Nuwara Eliya	325,022	168,879	156,143
	1,366,596	705,694	650,902

Standard of Living

The unsympathetic administration of the Waste Lands Ordinance deprived the peasants of most of his 'chena' and pasture lands. These lands were exploited for establishing plantation crops by capitalist interests, and in consequence the villages became congested. The rapid increase in population and consequent fragmentation of holdings into uneconomic units aggravated matters reducing the peasantry to near starvation. The importation of large numbers of Indian labourers by the planting industry deprived the peasants of employment in the vicinity of the villages. Thus a one time happy, contented and robust peasantry, deprived of both land and resources and any benefits in the way of employment, were reduced to penury.

This acute congestion has in recent times been relieved by settling peasants, at considerable expense, on some Tea, Rubber, Coconut and Cacao Estates acquired by Government and on Crown land where available. In addition large numbers of peasants have been settled in major colonization schemes in various parts of the Island.

In recent years the flight of foreign capital invested in the plantation economy and the transfer of ownership of plantations to Indian and Ceylonese capitalists have stimulated in the middle-classes a desire to own plantation property. Some speculators taking advantage of this trend have purchased economically sound plantations and disposed of them in uneconomic units at relatively high prices to middle-class purchasers who neither own sufficient capital nor command necessary credit facilities to purchase economic units.

This type of fragmentation should be prevented as it would adversely affect the economy of the country which is mainly dependent on the prosperity of the plantation crops.

The chronic state of indebtedness of the peasants to the local boutique-keepers in the past has disappeared to an appreciable extent and a degree of prosperity has resulted since the establishment of Co-operative Credit Societies and Co-operative Production and Sales Societies. Government subsidies and guaranteed prices operated through these organisations have very appreciably ameliorated the economic handicaps and stimulated production. The main incentive to increase production has been the Guaranteed Purchase Price Scheme of some commodities.

Soils of the Central Division

The main rock types from which the soils of this Division are formed is the Khondolite groups of rocks resting on fundamental Gneiss. Veins of dolomitic lime stone also occur in the Dambulla—Nalanda—Matale belt and in Teldeniya—Marassana—Ampitiya. Being in the midzone, climate has not exerted its influence to any degree on the characteristics of the soil types.

The soils are lateritic and red or yellow in colour, but variations of all shades between pinkish and red and yellowish brown could be observed. On some exposed steep hill sides erosion has removed the surface soil exposing the underlying decomposing rock known as rock brash. Small flakes of mica are often present. In texture some soils vary from loam to heavy loam and though acid in reaction, these soils are

fairly well supplied with calcium and potash. The phosphoric acid content is low and the nitrogen content is variable. Application of nitrogen and phosphoric acid in the form of manures to paddy soils prove beneficial.

The lime stone soils need potash in addition to nitrogen and phosphoric acid. Black peaty soils ranging from 6″ 18″ in depth are present in the wet high elevations in and around Nuwara Eliya.

In the Kotmale region the configuration of the land is steep and the substratum of Gneiss rock is overspread with a loose quartizitic clay with a layer of lateritic soil above it. This formation in a heavy rainfall region being effected by the indiscriminate removal of protecting forest cover on the hill tops and steep slopes and along streams may be the cause of frequent serious land slides in wet weather and rapid drought conditions in dry weather.

In areas subject to heavy rainfall plant nutrients are leached down in addition to erosion of unprotected soils by removal of the surface layers.

In this Division in most areas emphasis has to be made on soil conservation. Advisory work on the beneficial effects of soil conservation measures, viz., provision of wind belts, shade trees, contour terraces, contour drains, cover crops, strip cropping, &c., is undertaken. In addition demonstration plots have been established.

Acreage of Land

The total acreage of land in the Central Province is 1,465,632. Of the cultivable extent of 741,224 acres 566,744 or 76.46 per cent. are cultivated and 174,480 acres or 23.54 per cent. are uncultivated.

Patana Lands

Patanas or talawas are wide stretches and grass lands mainly of *Mana* (*Cymbopogon confertifforus* Stapf.) with scattered trees of *kahata* (*Careya coccinea* A. Chev.), *bulu* (*Terminalia belerica.* Roxb.), *nelli* (*Emblica officinalis.*—Gaertn.) and *gammalu* (*Pterocarpus marsupium.* Roxb.) occurring in all elevations. The wider stretches of *patanas* in this Division exist on the slopes and plateaux nearer the hill tops in elevation between 1,600-7,500 feet. In the *patanas* over 5,000 feet (*Rhododendron arboreum* Sm.) and a few scattered trees of *kahata, bulu* and *nelli* are to be found. The exposed windswept parts of the *patanas* could be converted into valuable and much needed pastures if the annual firing of the *mana* grass in the dry weather is rigorously suppressed. Valuable timber coppices too could be established and economic crops also grown by providing adequate wind belts. Soil conservation measures, however, should be insisted on if and when these *patana* lands are developed under economic crops or as timber coppices.

In preliminary trials with Citronella (*Cymbopogonnardus* L.), in the semi-dry regions of Uda Hewaheta and Uda Dumbara, growth was promising. The citrol content, however, of the crops grown in the above areas has not yet been determined.

Land Utilization

The acreage of crops excluding town and village gardens is 543,626 comprising of :—

Tea	310,072
Rubber	84,712
Coconuts	32,169
Rice	75,139
Chena	8,685
Other cultivations ..	32,849

Perennial Crops

TEA : (*Camellia sinensis* (L.) Oktze.)

Of the total extent of 572,008 acres under Tea in the Island, 310,072 acres are in the Central Division. In 'A' Estates comprising of 816 holdings, 356,112 acres are cultivated and 59,078 acres are uncultivated. In 'B' Estates comprising of 431 holdings, 15,329 acres are cultivated and 6,925 acres lie uncultivated.

In addition there are 37,151 smallholdings, in extent 92,129 acres, of which 76,006 acres are cultivated.

The 'A' Estates are well maintained and tea manufactured on these estates, both in the mid and up-country regions, fetch a higher price in the world markets owing to their bouquet and flavour. These teas are used for bulking with tea produced elsewhere.

A Smallholdings Advisory Service was established in 1952 by the Tea Research Institute. Assistance to smallholders under 20 acres in extent is afforded by Government through Co-operative Societies by making available manure at subsidized rates, cash advances up to Rs. 90 per acre and outright grant of Rs. 20 per acre for soil conservation work in addition to providing marketing facilities, &c.

By the Tea Control Act new areas in tea could be planted only under the authority of a licence under section II. New clearings and holdings where vacancies exceed 50 per cent. are compelled by an Ordinance to plant the lands on the contour.

The disease Blister Blight (*Exobasidium Vexans*) which has spread to Ceylon from India, in recent years, caused considerable alarm. It is, however, now under control by regulating shade and regular sprayings of copper fungicides. Several estates have interested themselves in selecting Blight-resistant clonal material for propagation.

RUBBER : (*Hevea Braziliensis* L.)

Rubber estates are generally found at elevations below 2,000 feet in areas where the rainfall is not below 80" and is well distributed. The few estates above 2,000 feet are not doing well. The acreage under rubber in this Division is 84,712. But most of the estates were slaughter tapped during the war years. The Government Replanting Subsidy Scheme assists proprietors of uneconomic rubber lands who desire to replant with approved varieties of high-yielding rubber. The above Scheme has been modified recently in respect of areas where cacao would be more suitable. Government has undertaken to pay a subsidy of Rs. 350 per acre for estates which are under-planted in cacao. In recent years many rubber estates have been under-planted in cacao and the results are very promising.

The control of *Oidium* by sulphur-dusting is enforced by law on all rubber estates over 50 acres in extent.

A potential danger which should not be lost sight of is the likely omission to keep a watch on the spread of *Oidium* from the uneconomic and abandoned rubber on estates under-planted with other crops, viz., cacao, coconuts, &c.

CACAO : (*Theobroma Cacao* L.)

Most of the important cacao estates are in the Kandy and Matale Districts at an elevation of 500 to 2,000 feet, in areas protected from winds and in well

drained soils. In recent years new plantations have been established in uneconomic rubber estates and under marginal rubber in the semi-dry zone. The estimated acreage is about 50,000 acres.

The Criollo or Old Ceylon Red of the earlier plantations have disappeared as a result of cross pollination over a period of years with the more dominant Forastero type introduced later. And the present type is not unlike the Trinitario Cacao of Trinidad which is predominantly a mixture of Forastero and of Criollo types and other types. In the plantations there is a considerable mixture of the Amelonado type. Propagation by rooted cuttings is fast gaining favour.

Phytophthora which causes pod rot and canker is the most serious disease of cacao in areas with high rainfall. *Helopeltis* bug attacks the young flush and pods and also favours the incidence of *Phytophthora* pod rot. The control of shade and regular pruning of cacao are essential in the proper management of a plantation as too much shade encourages incidence of *Phytophthora* while too little shade encourages *Helopeltis* attack. Sudden removal of shade or exposure of cacao trees to excessive light as when patches of cacao are cleared, results in retarded growth followed by death of trees in the perimeter of the cleared patches. A regular programme of manuring with organic manures and fertilizers is essential both for maintenance of production and for prevention of nutritional disorders to which the cacao is susceptible.

COCONUTS : (*Cocos nucifera* L.)

The total acreage under coconuts is 32,169 acres excluding figures for holdings of less than 1 acre in extent. Of this, 9,403 acres constitute estates of over 20 acres. Although a few coconut palms are found in most holdings even in elevations above 2,500 feet in sheltered localities, they are very shy bearers at higher elevation. Many plantations, both estates and smallholdings, are aged and call for re-planting. The Coconut Research Scheme has set up a rehabilitation scheme and is supplying selected seedlings at reasonable rates for underplanting under old coconuts and also for new plantations. There is room for extending the cultivation of coconuts in the medium and low elevations of the semi-dry parts of this Division.

SPICES :

The most important spices grown in the wet and semi-dry zones are :—

Pepper (*Piper nigrum* L.) requires a well distributed rainfall and grows up to about 4,000 feet. The vines are trained on to high shade trees on estates, home gardens and boundary fences. To facilitate harvest they are trained on to shade trees kept under control by pruning. About 4,218 acres are under pepper.

Cardamom (*Elettaria cardamonum.* Maton.) thrives best in moist-humus soils under light natural shade at an elevation of 2,500-6,000 feet. The forests are underbrushed and cardamom planted. About 1,821 acres are under cardamom.

Ginger (*Zingibar officinale* Roxb.) thrives best under well drained partial shade and requires a well tilled humus and loamy soil. Thrives up to 3,000 feet. About 452 acres are under ginger.

Turmeric (*Curcuma domestica* Val.) thrives under partial shade in light friable soil up to an elevation of 3,000

feet. About 438 acres are under turmeric.

Cloves (*Zyzgium aromaticum* (L.) Merr.), Nutmeg (*Myristicafragrans.* Houtt) and Vanilla (*Vanilla planifolia* Andr.) are found in home gardens and smallholdings in the same region.

Annual Crops

1. RICE (*Oryza sativa* L.)

Rice, being the staple food of the people, is cultivated near the homesteads whether conditions are favourable or not. The commercial production areas are in the dry zone. Large extents in this Division are on terraced fields on hill sides and in valleys. With the abandonment of the dry zone areas and the movement of the population to the hill country in the past almost all available minor sources of irrigation have been tapped for rice cultivation. Unfortunately, the indiscriminate clearing of forests in the higher reaches, for establishing plantation crops, has adversely affected these minor irrigation schemes which now run dry during even short spells of dry weather. In recent years Government has undertaken the augmentation of irrigation water supplies in all areas in addition to inaugurating several Major Irrigation Schemes. During and after World War II when the urge to increase food production was felt even the ill drained marshes and gullies in the higher elevation were 'asweddumized'. Successful cultivation of these areas is mainly dependent on proper drainage and reduction of acidity by liming. In this Division rice is grown under widely varying environmental conditions ranging from the warm, low dry zone areas, about 200 feet elevation, to the cool wet zone areas up to about 4,500 feet, and in soils varying from marshes with high peat content to stiff clay and loose gravelly soils with very low fertility, found chiefly in the steep hill slopes of Uda Dumbara, Uda Hewaheta and Walapone. Such widely varying environmental conditions demand varying cultural practices and a multiplicity of varieties (2), (3), (4).

The two main seasons of cultivation are *maha* and *yala* corresponding to the North-East and South-West Monsoons. There is, however, considerable variation in the seasons in Uda Dumbara, Uda Hewaheta and Walapone. Some varieties which take 5½ months from sowing to maturity in the dry zone area, take 6-6½ months in the wet mid elevations and extend their growth period to even 9 months in the cooler high elevations.

TABLE II (*a*)

CULTIVABLE PADDY LANDS IN THE CENTRAL DIVISION

MAHA SEASON

District	*Major Scheme*	*Minor Scheme*	*Rainfed*	*Total*
Kandy	4,334	15,839	20,886	41,059
Matale	3,941	7,150	6,451	17,542
Nuwara Eliya	1,830	14,001	707	16,538
Central Division	10,105	36,990	28,044	75,139

TABLE II (*b*)

CULTIVABLE PADDY LANDS IN THE CENTRAL DIVISION

YALA SEASON

District	*Major Scheme*	*Minor Scheme*	*Rainfed*	*Total*
Kandy	3,495	4,864	12,375	20,734
Matale	992	3,857	2,194	7,043
Nuwara Eliya	1,480	7,364	360	9,204
Central Division	5,967	16,085	14,929	36,981

TABLE III

ASWEDDUMIZED PADDY LANDS SHOWING HOLDINGS AND OWNERSHIP

District	*No. of Holdings*			*Average Size of Holding*
	Fully owned	*Other*	*Total*	
Kandy	35,629	31,396	67,025	3/5
Matale	20,678	17,964	38,642	3/5
Nuwara Eliya	15,617	9,845	25,462	7/10
Central Province	71,924	59,205	131,129	2/3

Emphasis in this Division is on the adoption of measures of intensification to step up yields. The set up since 1950 has been to establish at least one Seed Farm *cum* Demonstration Centre in each *vel muladeniya's* (Minor Irrigation Headman's) area where all the improved methods of cultivation suited to the particular tract are demonstrated each season. The size of the Seed Farm in a tract depends on the quantity of seed required for secondary multiplication to meet the seed requirements of the entire tract. Where recommended pure line selections exist they are multiplied on the Seed Farm; in areas where suitable pure lines are not available, the most popular local variety is mass-selected each season multiplied and issued. The response of mass-selected seed to good cultivation and manuring has been striking. The number of such Seed Farm *cum* Demonstration Centres in the Central Province are as follows:—

Kandy District	461
Matale District	402
Nuwara Eliya District	228
Total	1,091

Transplanting

Although transplanting is an established practice in the *maha* season in many parts of the Central Division, yet it is not as extensive as is generally assumed. After five years of intensive propaganda the acreage transplanted in *maha* 1952/53 according to the Statistical

Department reports was only 14,454 acres: This has been stepped up to 18,440 acres in 1953/54 and to 24,521 acres in *maha* 1954/55. The acreage fertilized has been increased from 14,213 acres in *maha* 1952/53 to 15,429 acres in *maha* 1953/54 and in *maha* 1954/55 to 24,501 acres. During the past one or two years transplanting of the short-term *yala* crop, particularly in paddy fields cultivated in rotation with vegetables, has become popular. An extent of 4,491 acres were transplanted in *yala* 1954. Paddy cultivation in this Division is more or less dependent on direct rainfall in most areas. The late arrival of monsoon rains, in some seasons, may result in abandoning nurseries already raised in anticipation of normal rains and in resorting to direct sowing of shorter-term varieties, thus causing a shrinkage in the extent which could have been transplanted and, particularly, in the extent under improved seed. The prevalence of the ancient system of *athan* or communal co-operative labour and the traditional dignity attached to this industry have enabled the practices of transplanting and hand-weeding, in some of the populous areas, to survive through the years even when the market price of paddy was below actual cost of production. In the sparsely populated areas and whenever arrangements for transplanting the normal long-term varieties have to be abandoned due to unforseen circumstances and shorter-term varieties grown, harrowing the standing crop is at present the only practical solution to the problem.

Statistics

In this Division extents of each measure of intensification adopted each season, on each holding, in each tract are recorded. The F. A. O. Statistician commented on these records as follows:—

> "In order to estimate the additional production due to measures of intensification it is necessary to note the actual area under these measures. It is gratifying to note that in the Central Province registers are being maintained in respect of each tract in which the names of the holders, the extent of the holding and the approximate extent of each measure of intensification, are recorded by the Food Production Officers and the *Vel Muladeniyas*. Thus complete enumeration records of measures of intensification are available in this Division."

The extents of some of the measures of intensification adopted in *maha* 1954/55 are as under:—

	Cultivable Acreage	*Extent under Fertilizers*	*Acreage transplanted*	*Acreage hand-weeded*
Kandy District ..	41,059	14,213	17,514	18,779
Matale District ..	17,542	7,208	4,882	8,652
Nuwara Eliya District	16,538	3,090	2,125	11,929
Total ..	75,139	24,501	24,521	39,360

The Modified Japanese Method of Rice Cultivation

Conditions obtaining in this Division are suited to the adoption of measures of intensification based on the principles of the Japanese Method of rice cultivation modified to suit local conditions. At several centres, in all three Districts, yields over 150 bushels per acre were obtained in the trials conducted in *maha* 1954/55. A disturbing feature, however, was the predisposition of the heavily manured rice crops to attacks of blast (*Piricularia oryzae*) and stem borer (*Schoenobius incertalus*). This points to the necessity for adopting routine spraying of insecticides as a preventive measure. One important feature in the Japanese Method of rice cultivation is transplanting of seedlings when they are 3-4 weeks old. The customary practice is to transplant seedlings when they are as many weeks old as the number of months the variety takes from sowing to maturity. In Ceylon too early transplanting of seedlings had been advocated by Rhind (5) in 1950, whilst in 1940, Wickramasekera (6) had advocated harrowing the standing broadcast rice crop when seedlings are 3-4 weeks old.

Paddy Yields

The average yields of paddy according to the Statistical Department crop sampling records are as follows :—

	1952/53	*1953/54*
Kandy ..	.. 32·65	.. 38·75
Matale ..	.. 30·78	.. 41·35 *
Nuwara Eliya	.. 44·12	.. 37·98 †
Central Province	.. 35· 2	.. 39·21

* High yields from about 2,000 acres of newly asweddumized land have been reflected in the high average yields.

† Drought conditions experienced adversely affected yields.

Although further extension of the present acreage transplanted, viz., 24,521 acres would be slow, yet by popularizing modifications of the Japanese Method of rice cultivation, wherever transplanting is feasible, and in other areas by harrowing the standing crop or hand-weeding and the application of the increased dosage of fertilizers now recommended, it would be possible to step up yields to an average of 55 bushels per acre. The limiting factor, however, would be ability and willingness of cultivators to purchase the necessary fertilizers. If land-owners would assist tenant-cultivators to purchase fertilizers and recover a reasonable part of the cost, the objective could be reached early.

Highland Crops

Every variety of food crop grown in the Island could be grown in this Division, and in addition some sub-tropical vegetables and fruit trees in the higher elevations. Large extents of land are available for extension in Uda Dumbara, Matale North, Matale East, Uda Hewaheta and Walapone. Cultivation in these areas is generally possible only in the *maha* season as in *yala* most areas are strongly wind-swept and very little or no rain falls.

Tobacco

The cultivation of cigarette tobacco is rapidly expanding in parts of Matale North, Pata Dumbara, Uda Dumbara, Pata Hewaheta, Uda Hewaheta and Walapone. In parts of Matale North and East and Pata Dumbara cigar and chewing varieties of tobacco are also grown. Preparation

of land for *chena* cultivation entails comparatively little disturbance to the soil surface, whilst the rest afforded after a season's cultivation enable regrowth of natural cover. The preparation of land for tobacco, however, necessitates deep tilling and removal of stumps and roots. Most of the tobacco lands are cultivated on annual leases. An unsatisfactory feature is that the lessees are not interested in soil conservation measures. Except in the flat lands of Matale North, wind and rain erosion on the steep lands in other areas prepared for tobacco is exceedingly heavy and in a few seasons these lands would become barren. Some form of legislation to ensure soil conservation on tobacco lands is a pressing necessity.

Potato

Solanum commersonii has been cultivated in the Nuwara Eliya District for over two decades without renewing seed potatoes. This variety is comparatively more resistant to blight (*Phytophthora infestans*). Several varieties of *Solanum tuberosum* were tested out: 'Great Scott' was the most promising.

EXTENTS AND YIELDS OF SOME HIGHLAND CROPS—MAHA 1953/54

	Approximate Acreage	*Yield*
Kurakkan (*Elausine coracana* Gaertn)	11,818	75,460 Bushels
Maize (*Zea mays*. L.)	3,336	20,995 ,,
Gingelly (*Sesamum indicum* L.)	234	1,907 ,,
Green Gram (*Phaseolus Aurens* Roxb.)	199	1,160 ,,
Cowpea (*Vigna sinensis* (L.) Ende)	431	2,114 ,,
Kollu (*Dolichos biflorus*)	312	2,873 ,,
Manioc (*Manihot utilissima*)	6,597	133,760 Cwt.
Sweet Potato (*Ipomaea batatas* Lam.)	2,814	34,904 ,,
Potato (*Solanum commersonii*)	121	811 ,,
Other root-crops	539	10,632 ,,
Chillies (*Capsicum annuum* L.)	2,938	11,990 ,,
Mustard (*Brassica juncea* Hk.f)	307	1,350 ,,
Onions (*Allium ascalonicum*. L)	896	9,294 ,,
Ginger (*Zingiber officinale* Roxb.)	737	9,742 ,,
Turmeric (*Curcuma loga* Val.)	480	5,576 ,,

Vegetable Cultivation

Market garden cultivation of vegetables has been an established Industry in Nuwara Eliya and Kandapola and also in Uda Hewaheta, Walapone, Pata Dumbara, Pata Hewaheta and Matale South mainly in rotation with rice. In the *chenas* low-country vegetables are cultivated extensively both as a mixed crop and as the main crop during the *maha* season.

Estates Food Production

Activities connected with food production as required by the Food Production (Estates) Act, No. 40 of 1954, play an

increasingly important part in this Division. A scheme of Exemption for Animal Husbandry (Milk Production) under section 8 of the Food Production (Estates) Act, No. 4 of 1954, is in operation.

Animal Husbandry

Statistics of livestock available is only in the Census Report, 1946. Many changes in stock have occurred since. Among imported dairy breeds Ayreshire, Friesian, Shorthorn, Red Poll, Jersey and also crosses of these predominate on up-country estates and dairies. These animals are collectively known locally as 'Cape' animals. The Indian Red Scindi breed is popular in the mid and lower elevations.

In order to up-grade the hardy local breed and cross-bred animals assistance is given by loaning stud bulls and establishing subsidized Stud Centres, and Artificial Insemination Centres. The local bulls are castrated free of charge. 'Tuberculin' tests are conducted on dairy cows.

A recent scheme is to give a bull calf of a good breed in exchange for two local bull calves of approximate weight.

The cultivation of fodder and pasture grasses is encouraged and advice on management, feeding, prevention and cure of diseases is made available free of charge.

Poultry

Cockerels of imported breeds are given in exchange for local cock birds or sold at the concession price of Rs. 5 each. Settings of eggs are sold at concession rates. White Leghorns, R. I. RR., and Austrolopps are popular. Birds are innoculated free of charge against Ranikhet disease.

Dogs

Mass anti-rabies innoculations are given free of charge. There is a Veterinary Hospital in Peradeniya, three Veterinary Dispensaries and four Artificial Insemination Centres in the Kandy District and one Veterinary Dispensary and one Artificial Insemination Centre each in Matale and Nuwara Eliya Districts.

The following Animal Husbandry Development Centres serve the Division:—

	Stud Bull Centres	*Stud Goat Centres*	*Poultry Centres*
Kandy	15	2	30
Matale	3	4	8
Nuwara Eliya	5	3	15
	23	9	53

References

1. Report of the Kandyan Peasantry Commission—*Sessional Papers, 1951.*

2. Leaflet No. 199—Food Production Leaflet No. 20 including annexures.

3. Wickramasekera, G. V.—'Paddy cultivation with special Reference to the results of Departmental Trials', 1944.

4. Wickramasekera, G. V.—'The cultivation of Paddy in the neighbourhood of Peradeniya'—*Tropical Agriculturist*, Vol. LXXII, 1929.

5. Rhind, D.—'Notes on the Improvement of the yields of Paddy in Ceylon.', 1950.

6. Wickramasekera, G. V.—'The effect of harrowing a Standing rice crop'—*Tropical Agriculturist* Vol. XCIV, 1940.

Terraced paddy fields—Kadugannawa

Pepper

Harvesting Cacao

Cabbage Garden—Up-country

A Programme of Livestock Breeding

A. V. ANKER-LADEFOGED AND P. MAHADEVAN

Cattle

ANY measures taken to improve the indigenous cattle of this country must have as their objective the increase in productivity of milk, draught and meat. For a long time to come the average local cow in Ceylon will be required to function as a dual-purpose or as a triple-purpose cow, i.e., for the production of either milk and draught or milk, draught and meat. However, it is generally agreed that any planned improvement programme should consider the improvement in milk production as its most important objective.

Such a programme should have in view :

(*a*) the evolution of a breed of cattle capable of producing a fair amount of milk (200 to 300 gallons) in a lactation of about 300 days on the minimum of supplementary feeding and calving down yearly. This would provide a suitable household cow for Ceylon's rural areas. The ability of male progeny to work well and produce a carcase of reasonable weight and quality should also be borne in mind ;

(*b*) the production of a type of cow that would be suitable for dairies in urban areas where better nutritional and managerial conditions can be provided and where a higher level of production is called for. This type is represented by the so-called 'Cape cow'.

Genetical studies on the general life and production statistics of the local (Sinhala) cattle have shown that there is not much prospect in the immediate future of converting the Sinhala cow into even a reasonably good milch animal by straight selection. The alternative, therefore, is to cross the local stock with foreign breeds of superior performance and interbreed or grade-up the progeny. The choice of a foreign breed for such crossing would naturally depend on the climatic, nutritional and managerial conditions under which the crosses are to be kept. For example, under poor nutritional and managerial conditions the introduction of 'blood' from European breeds into the local stock is to be deplored, while crossing with Indian breeds may be recommended since the latter are as tolerant as the indigenous animals to variations in levels of feeding and management.

A considerable amount of experimental work is now in progress to provide fundamental information on the effects of crossing *per se* on the rate of increase in milk production. Two lines of work are being undertaken :

(*a*) to investigate the rate of advance in milk production by continuous grading of Sinhala stock with Red Sindhi sires ;

(*b*) to determine the relative usefulness of different European breeds for crossing with local stock and subsequent interbreeding to produce a type of animal suited to urban dairies.

While the evolution of a long-term policy of cattle breeding must await the final results of these breeding

experiments, the following interim policy may be recommended on the basis of available data :

1. At up-country and mid-country elevations (2,000 ft. and above) grade up to European stock such as the Ayrshire or Friesian to produce good milch animals. In up-country areas the demand for draught bulls is not very great and the question of draught ability is therefore not of much consequence.

2. At low-country elevations in the wet zone, there are two possible alternatives. One is to grade up the local stock with Indian breeds such as the Red Sindhi or Tharparker, which possess all the desirable qualities of the local cattle such as draught ability, resistance to tropical diseases and ability to thrive on the fodder found in the low-country zone of Ceylon, besides being able to produce much more milk. Such grading would produce a dual purpose type of animal capable of giving about 200 to 300 gallons of milk per year, possessing good draught ability and reasonable quality meat, and, therefore, well suited to the rural areas of Ceylon. The other alternative applies to specialized dairies where good nutritional and managerial conditions obtain, and where a programme of crossing with Ayrshire or Friesian sires may be recommended.

3. Under dry zone conditions, grade up to Indian stock such as the Red Sindhi or Tharparker.

It would appear from this that we are placing considerable emphasis on the use of Indian breeds in the interim programme of cattle breeding recommended here. Apart from the many reasons that we have listed above in support of this, there is the important fact that the average peasant or cattle owner in rural areas is not likely, for quite some time, to be so well trained or to become so cattle-conscious as to enable him to look after highly bred stock of other breeds in an economic manner.

Buffaloes

In Ceylon two types of buffaloes are found, viz., the local or indigenous buffalo and the Murrah buffalo of Indian origin. Of the two, the Murrah is far superior for milk production while for draught and paddy field work the Murrah, although hardly inferior, is less popular as most cultivators consider the animal too heavy for such work. There are, however, several examples demonstrating that the Murrah is quite suitable for the type of draught required by the Ceylon peasant. We recommend the following breeding policy in respect of buffaloes :

1. For urban areas where milk production is the main consideration, use Murrah studs for grading up local stock.

2. In rural areas where a lighter type of animal is preferred, use either Murrah × Local (Crossbred) studs or purebred Murrah studs for grading up local stock. In this connection, it may be mentioned that in years to come with the growing tendency to mechanize all agricultural operations draught ability might become less important than it is today.

At present, very little buffalo milk is produced in Ceylon due to the existence of a prejudice against the consumption of buffalo milk except in the form of curd or ghee. It should, however, be noted that Ceylon has a female

buffalo population of about 280,000, and approximately 50 per cent. of these, comprising the adult females, may be regarded as a potential source of milk supply that could very profitably be tapped in the future.

Goats

Goats are reared in Ceylon largely for the purpose of meat, and Ceylon with its vast areas of jungle land could easily rear enough goats to be self-sufficient in respect of mutton. At present, however, this is far from being the case. The breeding of goats should, therefore, be given all possible assistance and encouragement. We recommend the following breeding programme for goats :

1. Where goats are maintained under range conditions (as large herds grazing on jungle land), crossbred Jamnapari studs (i. e., Jamnapari × Local) should be used.

2. Where goats are better cared for (as in the wet zone where each family maintains only a few goats and partly stallfeeds them), purebred Jamnapari studs or crossbred Jamnapari studs may be used. The crossbred progeny thus produced would, if well fed, be good meat producers besides being reasonably good milkers.

Methods of Implementation

For the implementation of the breeding policy outlined above, it is desirable that adequate attention be paid to the following :

1. Stud Centres and Artificial Insemination Units. These should follow very closely the breeding programme outlined here. As regards A.I. centres, a system should be devised to follow up the performance of at least of a random sample of the female progeny of each sire. It may also be mentioned in this connection that unless an A.I. unit caters to at least 500 cows per year within 3 years of its inception, its continuance should be carefully reconsidered.

2. Issue of Breeding Stock from Government Farms to the Public. It is incorrect to assume that Government Farms should serve as supply stations of female breeding stock to the public. Even after all Government Farms are fully stocked, the number of young females (except in the case of goats) that can possibly be issued to the public would be around 5 to 10 per year for every 100 cows in the herd. The reasons for this should be well known to anyone familiar with animal breeding practices.

The main point, however, is whether any tangible improvement can really be effected by the issue of female breeding stock to the country. It should be clear that the influence of even a few superior males on Ceylon's indigenous cattle population will be of very much greater benefit than that of the few young females that can be issued. After all, a heifer calf can benefit only the one individual who owns it, whereas a male can provide germ plasm to improve a whole section of the cattle population for many individual cattle owners. The greatest service that any State Cattle Farm can, therefore, render to the public lies in the number of superior male breeding stock that it can make available, and it should be possible with the present strength of our herds to satisfy every application from the public for male stock.

3. The Exchange Scheme for Livestock. In recent times, an exchange scheme for livestock has been introduced on the principle that pedigreed male breeding stock should be made available to the public in exchange for nondescript male stock. This scheme aims at the dissemination of superior germ plasm throughout the country without calling for any cash payment from the public, and at the same time helps in the gradual elimination of scrub animals. It should be persevered with particularly in areas where stud centres and artificial insemination units cannot function efficiently.

4. Periodic Ban on the Slaughter of Female Stock. Due to the religious sentiments of the people, castration is generally not approved of in this country, and in consequence the proportion of males to females in respect of neat cattle, buffaloes and goats is high. In fact there are almost as many males as females. Such a high male population of poor quality is bound to impede progress in breeding very considerably. It is, therefore, suggested that a ban on the slaughter of females be enforced periodically in order that the male population may be reduced. Such a step, when viewed in conjunction with the activities of stud centres, artificial insemination units, and the exchange scheme, would make for rapid progress in livestock breeding in the Island.

In this connection, it may be argued that the enforcement of a periodic ban on the slaughter of female stock may result in increased meat prices and may cause a shortage of draught bulls. We are, however, confident that neither of these two situations should arise as there would be plenty of males available for slaughter and for draught, and the ban, being periodic, would be in force for (say) only about a couple of years every two to three years. Moreover, it is possible that the demand for bullocks is likely to decrease gradually due to mechanization. As regards buffaloes, these are already protected against slaughter except for three months of the year.

5. Extension and Improvement of Pasture and Fodder areas. Along with the improvement of stock, it is most essential that the country's pasture and fodder areas be greatly extended and improved. There is immense scope for grassland improvement in Ceylon, and this should be encouraged as much as possible. It would appear that Rural Development and Co-operative Societies are in the best position to achieve this end.

6. Training of Personnel for Livestock Farming. In most districts in Ceylon, there are only a few good cattle farmers and cattle keepers. As well-trained personnel is very essential for the proper management of stock, it is suggested that practical training classes of 3 to 4 months duration be provided in all major livestock farms for those desirous of a practical training. A start is shortly to be made at Ambepussa Farm.

7. Marketing of Livestock Produce. The most practical encouragement that can be given to the development of the Island's livestock industry is, no doubt, the proper and efficient marketing of produce. The Government Milk Board which has been recently created for the marketing of milk, will, if successful in its approach, serve as an impetus to the public for the improvement of stock, and will also greatly facilitate the Livestock Extension and Advisory work of the Department of Agriculture.

The role of Government Livestock Farms in the Improvement of the Island's Livestock

No estimate has yet been made of the effect of Government-owned herds of livestock in changing the genetic composition of our livestock populations. But it is undoubted that such herds have the greatest opportunities for directing island-wide breeding operations. The number of farms owned by Government in this country is sufficiently large to provide adequate male breeding stock annually and to make it possible with the aid of the artificial insemination units, the stud centres, the exchange scheme, &c., to shape the Island's livestock industry in the matter of a few generations.

Of the many Government farms maintaining livestock, some are run as commercial enterprises to meet the demand for milk in the locality, some utilize the livestock for the purpose of maintaining soil fertility, some serve as practical demonstration centres to illustrate to the public the usefulness of keeping livestock, while a few are also utilized for experimental work on the breeding, feeding and management of livestock and on fodder production. To the last category belong the following farms, whose main objectives are also briefly stated below :

LIVESTOCK FARM, BOPATALAWA—

(*a*) To breed purebred Friesian and Jersey cattle for the purpose of supplying the public with breeding stock of temperate breeds.

(*b*) Milk production and to demonstrate to the public that farms of this nature can be run economically.

(*c*) To carry out investigations on breeding, feeding, dairy farm management and fodder production under the prevailing conditions.

(*d*) To breed Berkshire and Large White pigs.

LIVESTOCK FARM, AMBAWELA—

(*a*) To breed purebred Ayrshire cattle for the purpose of supplying the public with breeding stock.

(*b*) Milk production and to demonstrate to the public that farms of this nature can be run economically.

(*c*) To serve as a model dairy and to investigate problems on breeding, feeding and dairy farm management under the prevailing conditions.

(*d*) To breed Large Black pigs.

LIVESTOCK FARM, POLONNARUWA—

(*a*) To breed purebred Indian breeds of cattle and goats, i.e., Red Sindhi and Tharparker cattle and Jamnapari goats, for the purpose of supplying the public with breeding stock.

(*b*) Milk production and to demonstrate to the public that farms of this nature can be run economically.

(c) To carry out investigations on fodder conservation, and on the breeding, feeding and management of livestock.

(d) To establish pastures and fodders suited to dry zone conditions.

LIVESTOCK FARM, RIDIYAGAMA—

(a) To breed Murrah buffaloes and to conduct crossbreeding experiments with local buffaloes.

(b) Milk production and to demonstrate to the public that farms of this nature can be run economically.

(c) To carry out investigations on feeding, fodder conservation and farm management.

(d) To establish pastures and fodders suited to dry zone conditions.

(e) To breed goats to meet the local demand for breeding stock.

LIVESTOCK FARM, NIKAWERATIYA—

(a) To breed purebred draught cattle of Indian breeds to meet the demand for good plough and cart bulls.

(b) To carry out investigations on farm management and farm economy under ranch conditions.

(c) To establish pastures and fodders suited to dry zone conditions.

(d) To breed goats to meet the local demand for breeding stock.

LIVESTOCK FARM, KARAGODA UYANGODA—

(a) To conduct breeding experiments with Sinhala cattle.

(b) To carry out investigations on feeding and dairy farm management under the prevailing conditions.

(c) To establish pasture and fodder suited to wet low-land conditions.

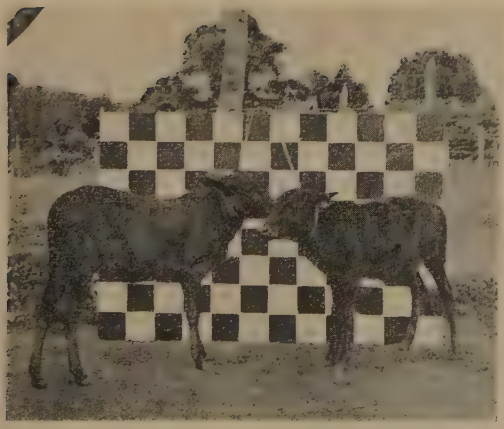
(d) To breed pigs with a view to popularizing pig keeping in the area.

The combined facilities thus available for livestock breeding and investigational work are very considerable, comprising some 5,000 head of stock and large acreages of land. An outstanding feature of the many achievements lying to the credit of these farms was the introduction, some 5 years ago, and the subsequent extensive establishment, of the African grass *Brachiaria brizantha*. This grass has now been found to thrive exceptionally well over a wide range of climatic conditions in Ceylon, so much so that it has almost revolutionized pasture development in this country.

Achievements of this nature need to be translated on an island-wide scale if any significant improvement in the livestock industry is to be achieved. The major livestock farms today not only serve as guides to the shaping of the Island's programme of livestock improvement, but also make it possible, with the numerous facilities they provide to the public, for the country to become self-sufficient in its requirements of milk, draught and meat.

Friesian stud bull, Barwyte Bargee, at Bopatalawa Livestock Farm.

Red Sindhi heifers on Brachiaria brizantha pasture.



Two contemporary heifer calves reared on different planes of nutrition.

A herd of Tharparker cattle at Polonnaruwa Livestock Farm.

Improvement of the Quality of Flue-cured Cigarette Tobacco in Jaffna Peninsula

A. B. ATTYGALLE AND E. JAYANETTI

Introduction

THE development of the cigarette tobacco industry in Jaffna Peninsula is beset with a serious problem in that the flue-cured tobacco produced has generally shown poor quality.

The outstanding characteristics of cigarette tobacco are its bright lemon to orange colour, its distinctive and mild aroma and its high sugar content. These are in contrast to the dark colour, coarse texture, strong flavour and aroma, high nitrogen and nicotine content of the chewing and smoking tobaccos already been grown in the Peninsula.

The burning quality of the tobacco is of prime importance. Cigarette tobacco leaf must possess good burning quality, resulting in evenness of burn and light adhesive ash. The cigarette tobacco produced in Jaffna Peninsula have generally shown poor colour and coarse texture. The leaf is thin and papery and the burning quality has been unsatisfactory.

Earlier Work

In 1914, B. Scherifius (a tobacco planter engaged by Government) made an attempt to produce cigarette tobacco in Jaffna Peninsula. After 3 years of trials with a large number of varieties and their leaf analyses at the Imperial Institute, London, he came to the conclusion "that flue-cured tobacco cannot be produced under the soil and climatic conditions prevailing in Jaffna, and that the production of high grade tobacco of the cigar types suitable for European markets is unlikely owing to the bad burning qualities caused by excess of chlorine". (1) The tobaccos produced were coarse and high in nitrogen and nicotine contents, (2) Because of these unfavourable reports on *flue-cured tobaccos* and the satisfactory results obtained with *air-cured* White Burley tobacco attempts to produce flue-cured cigarette tobacco leaf were not then pursued.

When the White Burley market failed in 1935 and the demand for other types of tobacco produced in Jaffna became low, there was a demand again in Jaffna to produce cigarette tobacco leaf. Trials were commenced with the formation of the Tobacco Division, Department of Agriculture, in 1939. The principal objects of these trials, conducted at the Farm School, Tinneveli, Jaffna, were to ascertain the optimum frequency of irrigation for cigarette tobacco, suitable rotations and varieties.

In 1949, due to falling market of Jaffna tobacco, both chewing and cigar, trials were started afresh by the Tobacco Division to develop the cigarette tobacco industry in Jaffna as a substitute.

In 1949-50 (Maha), preliminary trials were carried out at the following 7 centres with the main object of finding out whether cigarette tobacco of good quality and burn could be produced :— Centres : Valigamam North and East,

Point Pedro, Thenmaradchi, Sudumalai, Mathagal and Tinneweli Farm School. The results showed that at the centres Valigamam North and East and Thenmaradchi only the burn was good. The quality of cured leaf was generally poor and there was a high percentage of perished leaf.

In the years 1950-51 and 1951-52, trial cultivations were carried out at 4 centres, viz., Neerveli, Tellipalai, Vembirai and Uduvil, in farmers fields. Though there was an improvement in the quality of leaf, the manufacturing companies reported unfavourably on the burn of these tobacco except at Neervely vide article on "The Development of the Tobacco Industry in the Jaffna Peninsula". (3) The necessity for research on the aspects of production of cigarette tobacco of quality and good burn was indicated.

Research Studies

TRIAL No. 1

In Maha 1952-53, a trial "to ascertain the cause of poor combustibility of Jaffna cigarette tobacco" was carried out at the 4 centres (Neerveli, Tellipalai, Vembirai, Uduvil) and the Tinneveli Farm. The flue-cured tobaccos produced. were analysed by the Chemical Division, Department of Agriculture, tested for burn and compared with samples of Hingurakgoda and Anuradhapura tobacco of reputedly good burn. The results are given in Appendix A.

The results showed a certain amount of correlation between the burning quality and the percentage of chlorine and potash. The nitrogen content of the poor burning tobacco was high.

There was a large percentage of low grades and perished leaf in all the Jaffna centres.

TRIAL No. 2

In view of the above indication (and as the chlorine content was the more difficult to control) an experiment was laid out at Tinneveli Farm in 1953-54 "to study the effect of high potash and low nitrogen on the burning quality of tobacco". Factors (3 levels).

N. 0 , 6 , 12 , lb. nitrogen per acre (as sulphate of ammonia).

P. 0 , 42 , 84 , lb. phosphate per acre (as superphosphate (conc.)).

K. 20 , 48 , 96 , lb. potash per acre (as sulphate of potash). A 3 × 3 × 3 factorial in 2 replicates. Unfortunately continuous heavy rains during December/January severely affected the trials. The cured leaf, however, contained little perished leaf.

TRIAL No. 3

In Maha 1954-55, an experiment was laid out at the Tinneveli Farm "to improve the burning quality of the cigarette tobacco leaf produced".

Treatments

Three levels of Potash—0, 125, 250 lb. sulphate of potash per acre (48 per cent. K. 20).

Three levels of topping—untopped, 10, 15 leaves.

Two levels of organic manure—0, 2 tons F. Y. M. per acre. A 3 × 3 × 2 randomised block experiment (4 replicates). All plots were given 100 lb. per acre rate of superphosphate (conc.).

No Nitrogenous Fertilizer was applied

The results are given in Appendix B.

The improvement in colour and texture of the leaf produced was evident in the field. The tobacco grades were also better after curing—72 per cent. top grade (1, 2 and 3) were obtained. *No perished leaf was produced.* The manufacturing company reported that the tobacco had "fair burn", and laboratory test for burn indicated an improvement in burn in certain treatments.

It is to be noted that no nitrogen and reduced phosphate was applied in this trial.

Discussion—Part I

EFFECT ON QUALITY

In cigarette tobacco colour is the chief criterion in grading. A bright lemon to orange colour is most desired. The leaf should possess medium texture and body and mild aroma.

In the earlier years and as shown in Trial I, the cured leaf produced was rated low in the grading. Most of the leaf produced was brown in colour, with a papery or brittle texture and lighter in weight than normal leaf. Much perished leaf unsuitable in manufacture was produced.

Research by Johanson (4) of the Commonwealth Scientific Industrial Research Organization, Division of Plant Industry, Australia, has shown that this type of leaf has, in the uncured state, is characterized by extremely low sugar content and relatively high nitrogen content. The nitrogen content of good quality leaf varied from 1.0 to 2.0 per cent. and that of poor leaf from 2.5 to 3.0 per cent.

As the Jaffna cigarette tobaccos were high in nitrogen content an experiment was set out to study the effect of low nitrogen on the quality of cigarette tobacco in Maha 1953-54 season. This experiment (Trial No. 2) was severely affected by continuous heavy rain. No discussion of the results is therefore warranted though the experiment as a whole produced leaf of the better grades.

In the experiment of Maha 1954-55 (Trial No. 3) nitrogen was completely excluded from the trial. The immediate effects of this was apparent in the field —leaves showing light colour. The cured leaf showed high percentage of top grades—the 3 top grades being approximately 72 per cent. of the crop. No perished leaf was produced. This was a significant result.

Leaf analysis, however, revealed that the nitrogen content was of the order 2.04 to 2.69 per cent. (Appendix B) indicating that the soil was well stocked with nitrogen. The production of poor quality cigarette tobacco leaf in the Jaffna soils where the standard of cultivation is high and the soils are rich in nitrogen can thus be explained.

It had been suggested that shading reduces the carbohydrates level and increases the nitrogen content of leaf. Low topping was therefore suggested as a means of reducing shading and it also prevents the transport of sugars to the apex at the critical period. In the experiment conducted (Trial No. 3) the topping treatments have given better grades of cured leaf than the untopped treatments, though the nitrogen con-

tents showed increase with lowness of topping. The yield, however, decreased substantially with less than 15 leaved plants. Topping below 15 leaves cannot, therefore, be recommended. It may be that a higher level (say 16-18 leaves) of topping may be nearer the optimum. The organic manure and potash treatments failed to impress on the quality of the tobacco, though yields have been visibly affected. Their effects on the burn of the tobacco produced are discussed in Part II.

Summary and Conclusions

The necessity for improvement of the quality of cigarette tobacco produced in Jaffna Peninsula is stressed and the results of 3 trials carried out by the Tobacco Division of the Department of Agrciulture at various centres in the Peninsula and at the Farm School, Tinneveli, during the seasons 1952-53, 1953-54 and 1954-55 are reported. The chemical analyses of soil, water and leaf samples done by the Chemical Division, Department of Agriculture, are tabulated and discussed in Part II.

The following findings in regard to the improvement of quality and burn of the Jaffna cigarette tobacco are given :—

(1) The production of brown coloured, thin and papery leaf of poor quality could be eliminated by reduction of nitrogen in the fertilizer mixture. Heavy organic manuring and cattle penning which would tend to enrich the nitrogen status of the soil should also be avoided. The growing of a leguminous green manure crop in the rotation *just prior* to cigarette tobacco is also detrimental to burn of the tobaccos produced.

Leaf analyses of nitrogen content could indicate any necessity for nitrogen fertilization in Jaffna soil. A leaf nitrogen of less than 2 per cent. should be aimed at.

(2) From the point of view of yield and quality the height of topping may be at 16-18 leaves. From the point of view of burn however, a higher level of topping seems better.

(3) As discussed (in Part II) improvement in the burning quality of flue-cured tobaccos produced in certain centres of the Jaffna Peninsula appears promising, by lowering the nitrogen, lime and magnesia contents and increasing the potash content in the leaf. This may be achieved in some measure by suitable application of fertilizers.

The chloride content of the leaf is more difficult to control owing to the proximity of the Jaffna tobacco centres to sea and lagoon.

(4) Further research on the improvement of quality and burn of the flue-cured cigarette tobacco in Jaffna is being undertaken.

References

(1) Report for Local Tobacco Committee, Jaffna, on tobacco trials at Jaffna during 1914-17 by the Director of Agriculture—May 14, 1947.

(2) Imperial Institute, London—Report on Tobacco from Ceylon dated February 23, 1916.

(3) Development of the Cigarette Tobacco Industry in Jaffna Peninsula—article in Tropical Agriculturist (under publication).

(4) Australian Government Trade Information Service—*Agricultural Newsletter No. AGN/439*—Trashy Leaf of Tobacco.

APPENDIX A

Trial No. 1.—TOBACCO LEAF CURED GRADES

Grade	*1*	*2*	*3*	*4*	*5*	*Perished*	*Total Per Cent.*
Neerveli	9·0	15·5	15·5	30·0	8·0	22·0	100
Uduvil	3·5	8·0	22·0	37·5	14·0	15·0	100
Tellipalai	6·0	13·0	20·0	28·5	7·3	25·2	100
Vembirai	8·7	23·8	20·0	23·8	8·7	15·0	100
Tinneveli	—	20·5	11·8	64·6	—	3·1	100

CHEMICAL ANALYSES OF LEAF

	Nitrogen Per Cent.	*Chlorine Per Cent.*	*Potash Per Cent.*	*Burn (time in seconds)*
Neerveli	2·46	2·73	1·61	3·0
Uduvil	2·94	4·44	1·65	0·0
Tellipallai	2·68	3·76	1·48	0·5
Vembirai	3·16	4·48	3·14	1·5
Tinneveli	3·11	4·77	1·81	0·0
Anuradhapura	1·34	1·48	2·31	9·0
Hingurakgoda	1·29	1·01	2·75	13·0

APPENDIX B

YIELD—SUMMARY

Treatments	*Yield (oz.)*	*No. of Plants*	*Treatments*	*Yield (oz.)*	*No. of Plants*
M. 0. (no manure)	2,281·25	926	T. 2. (15 leaves)	1,584·25	605
M. 1. (2 tons/acre)	2,324·50	894	K. 0 (0 K 20)	1,482·25	600
T. 0. (untopped)	1,590·75	595	K. 1. (125 lb. S. P.)	1,472·25	610
T. 1. (10 leaves)	1,430·75	620	K. 2. (250 lb. S. P.)	1,651· 0	610

LEAF GRADES (P.C.)

Grade	*1*	*2*	*3*	*4*	*5*	*Perished*	*Total*
M. 0.	41·6	23·0	6·4	28·0	1·0	—	100
M. 1	41·0	24·4	8·6	25·0	1·0	—	100
T. O.	38·9	23·7	5·3	31·2	0·9	—	100
T. 1	41·9	24·7	12·9	20·6	0·1	—	100
T. 2	43·1	22·7	4·9	29·5	0·8	—	100
K. 0.	41·9	21·6	7·6	28·9	—	—	100
K. 1.	41·3	25·5	7·7	25·6	—	—	100
K. 2.	40·7	23·9	7·0	27·4	1·0	—	100

CHEMICAL ANALYSES

Topping Treatments

	Nitrogen Per Cent.
Un-topped—	
—K0 M0	2·09
K0 M1	2·04
K1 M0	2·23
K1 M1	2·21
K2 M0	2·50
K2 M1	2·32
Topped (at 10 leaves)—T1	
—K0 M0	2·46
K0 M1	2·27
K1 M0	2·44
K1 M1	2·54
K2 M0	2·64
K2 M1	2·66
Topped (at 15 leaves)—T2	
—K0 M0	2·25
K0 M1	2·35
K1 M0	2·53
K1 M1	2·54
K2 M0	2·62
K2 M1	2·69

The Effect of Manuring on the Burning Quality

S. KANDIAH AND D. M. RODRIGO

SAMPLES of cured tobacco from the trials outlined above by the Tobacco Officer were analysed for nitrogen and ash constituents in the Chemical Division of the Department. Standard methods were adopted for analysis and the results are expressed on a moisture free basis. Fire holding capacity of the samples was tested by means of an electric leaf burn apparatus. Although the information obtained is not conclusive and many aspects of the problem remain to be investigated, a certain amount of advance has however been made in improving the burning quality of the product, and it was considered useful to publish the results obtained so far.

Before outlining the results of the trials and discussing them, it is necessary to consider briefly the chemical constituents of tobacco which affect adversely or beneficially its burning quality. Of the various inorganic and organic constituents of the tobacco leaf, only three are known to affect to any marked degree its burning quality and certain others to a limited extent. Schloesing (1) was the first to point out the beneficial effect of potash and Nessler (2) the detrimental affect of chlorine. Anderson and his coworkers (3) demonstrated that, in addition, all nitrogenous compounds with the exception of nitrates had an adverse effect on burning. Attoe (4) examined statistically the results of analysis of a number of samples of tobacco and evaluated the relative influence of each of the constituents in affecting the fireholding capacity of tobacco. By working out the multiple regression equation he pointed out that nitrogen was 1.46 times more detrimental to leaf burn than potash was beneficial and 1.22 times more detrimental than chlorine. It would therefore be seen that nitrogen is the most harmful constituent, as far as burning is concerned and chlorine comes next, while potash is beneficial. Woltz, Reid and Colwell (5) studied the influence of nitrogen, calcium, magnesium, potassium, phosphorus and chlorine on the nitrogenous fraction of the tobacco leaf and pointed that chlorine, potassium and magnesium did not have any significant effect while nitrogen and calcium showed a positive and phosphorus a negative relationship. Darkis *et al* (6) have shown that tobacco grown on limed soils was rich in protein as lime encouraged the decomposition of organic matter making nitrogen available in increased amounts to the plant and this results in the production of high amounts of nitrogenous products.

Investigations

Trial 1. The soils of the Jaffna Peninsula are derived from Miocene limestone which is of marine origin. Owing to the nature of their parent material and their close proximity to the sea and the lagoon, one would expect the Jaffna soils and the well waters to be high in their chlorine contents. As chlorine is one of the constituents having an adverse effect on the burning

quality of tobacco, the first step taken was to ascertain, in Maha 1952/53, the chlorine contents of the soils and of the irrigation waters from four of the main tobacco growing centres, viz., Neerveli, Vembirai, Uduvil, Tellippalai and from the Experiment Station, Tinnevely, where future trials were to be conducted. Three samples of soils and waters were collected from each of the four centres and two from Tinnevely. As tobacco from Anuradhapura and Hingurakgoda were reputed to be of better quality, samples of soils and waters from these centres were also included for purposes of comparison.

TABLE I—Analysis of Tobacco Soils and Waters (Trial I)

	Soils		*Waters—parts per 100,000*			
	pH	*p.p.m. chlorine*	*pH*	*Chlorine*	*Total Solids*	*Total Sol. Salts*
Neervali I	7·3	60·0	7·5	13·6	54·0	53·4
Neervali II	8·0	6·0	7·0	4·3	35·0	35·0
Neervali III	7·6	18·0	7·5	8·3	25·1	25·1
Vembirai I	8·1	36·0	7·3	4·1	128·9	123·7
Vembirai II	8·3	12·0	7·4	1·6	34·6	34·6
Vembirai III	8·3	42·0	7·6	4·3	126·7	122·3
Uduvil I	8·3	24·0	7·3	4·3	129·3	128·3
Uduvil II	7·6	12·0	7·6	2·5	87·8	86·2
Uduvil III	8·2	12·0	7·3	2·9	107·8	103·1
Tallipaillai I	8·2	18·0	7·3	1·7	68·1	67·3
Tallipaillai II	7·2	48·0	7·5	2·4	93·3	83·3
Tallipaillai III	8·3	18·0	7·1	9·0	227·6	218·6
Tinnevelly I	7·9	6·0	7·5	1·8	36·0	36·0
Tinnevelly II	7·6	24·0	7·3	1·5	69·0	65·0
Anuradhapura I	6·3	3·6	7·0	4·6	17·5	15·5
Hingurakgoda I	6·6	3·0	7·0	2·2	17·5	14·5

A glance at Table 1 would indicate that the Jaffna soils are all highly alkaline in reaction and the chlorine values vary from 6.0 to 60 p.p.m. Marked variation in the chlorine contents of both soil and water among the three samples from each of these centres could also be observed. The pH values of the waters are lower than those of the soils and the chlorine contents vary from 1.6 to 10.6 parts per 100,000. The variation in general or among those from each of the centres too is large. A direct correlation could however be observed between the chlorine content of the soil and that of the water from any one place. The soils and waters from Anuradhapura and Hingurakgoda are much less in their chlorine content than those from Jaffna, and the pH values, particularly of the soils, are much lower.

The analysis of tobacco from only one area at each of the centres and its fire-holding capacity expressed in seconds have been carried out. The results are shown in Table II.

Table II—Leaf Analysis (Trial I)

	Ash Per cent.	*Nitrogen Per cent.*	*Potash Per cent.*	*Chlorine Per cent.*	*Nitrogen/ Potassium Ratio*	*Fire holding capacity (in seconds)*
Neerveli I	17.11	2.46	1.61	2.73	1.84	3.0
Vembirai II	20.56	3.16	3.14	4.46	1.21	1.5
Uduvil II	20.02	2.94	1.65	4.44	2.15	0
Tallipillai II	18.21	2.68	1.48	3.76	2.18	0.5
Tinnevelly I	17.54	3.11	1.81	4.77	2.07	0
Anuradhapura	10.45	1.34	2.31	1.48	0.70	9,0
Hingurakgoda	12.85	1.29	2.75	1.01	0.57	13.0

It will be observed from Table II that nitrogen and chlorine contents are high in all the Jaffna tobaccos and their burn is therefore adversely affected when compared with those of the better burning samples from Anuradhapura and Hingurakgoda. Among the Jaffna samples, Neervali despite its low potash shows the best burn evidently due to its low nitrogen and low chlorine values. Vembirai on the other hand is quite high in potash but its burning value has been brought down by the comparatively high nitrogen and chlorine. Gribbins (7) working on the fire holding capacity of a number of samples found that well burning tobacco had a nitrogen/potassium ratio of about 0.73. It will be seen that this ratio is very much higher in all the Jaffna samples while it is about the same with Anuradhapura sample and even lower with the best burning Hingurakgoda sample. A fairly high correlation could thus be observed between the N/K ratio and the burning quality of tobacco.

Trial II. This trial was designed to study the effect of nitrogen, phosphoric acid and potash, each at three levels on the burning quality of the product. The quantity of each constituent applied is shown in the table. Owing to the adverse effect of nitrogen on burning, it was kept very low. The amount of potash is fairly high, but the dosage of phosphoric acid is about normal. The analysis of only samples from the third level of treatment in each case and the control was carried out and the results are set out in Table III.

Table III—Leaf Analysis (Trial II)

Treatment—	*Levels* 0	1	2	
Nitrogen	0	6	12	*lbs. of nitrogen per acre as sulphate of ammobia*
Phos. acid	0	42	84	*lbs. of P2O5 per acre as concentrated superphosphate*
Potash	0	48	96	*lbs. of K2 O per acre as sulphate of potash.*

	Treatments N:	P:	K:	*Ash Per Cent.*	*Nitrogen Per Cent.*	*Potash Per Cent.*	*Phos. acid Per Cent.*	*Calcium Oxide Per Cent.*	*Magnesium Oxide Per Cent.*	*Chlorine Per Cent.*	*Nitrogen/ Potassium Ratio*	*Fire-holding capacity (in secs.)*
1.	0	0	0	19·65	2·96	1·30	·59	9·32	1·27	2·82	2·74	1·0
2.	2	0	0	20·23	2·56	1·37	·69	8·50	0·87	4·93	2·25	1·0
3.	0	2	0	20·40	2·88	·91	·95	8·83	1·06	5·08	3·79	·3
4.	0	0	2	20·43	3·15	·87	·77	8·86	0·51	4·41	4·37	0
5.	2	2	0	18·21	3·30	1·50	·65	7·59	1·06	3·07	2·66	1·0
6.	2	0	2	21·55	3·26	1·44	·70	8·79	1·26	3·19	2·74	·3
7.	0	2	2	23·20	2·50	1·66	·77	7·94	0·85	4·65	1·81	1·5
8.	2	2	2	22·90	2·62	·97	·77	8·26	1·00	3·64	3·28	·3

Certain trends could be observed from the results of the limited number of analysis carried out. Due to ionon-antagonism, the high calcium in the leaf has brought down the percentage of potash. Johnson and his associates (8) have shown that calcium and magnesium when present in large quantities impair the burning quality of tobacco. The low potash and the comparatively high chlorine has therefore impaired the burning quality of tobacco and this is generally borne out by the high N/K ratio. It will also be seen that some samples despite their high potash are low in burning. Garner (9) had pointed out that it is not the total amount of potash, but it is the quantity that is in combination with organic acids that promotes burning. The amount of potash in combination with organic acids would depend on the relative amounts of chlorides, sulphates and phosphates on the one hand and of calcium and magnesium on the other.

One other inexplicable point is that the treatments, nitrogen alone or potash alone had reduced the percentage value for the respective constituent to about the lowest level and this is reflected both in the N/K ratio and in the fire-holding capacity in these two treatments.

Trial III. In the light of the experience gained in the above trials, nitrogen as an inorganic fertilizer was omitted completely in this trial, but a basal dressing of 100 lbs. of superphosphate concentrated was given to all the plots. The design was a factorial one to test the effect of potash at three levels and well rotted cattle manure at two levels and of the cultural treatment of no topping as against topping at 12 and 20 leaves.

The samples were analysed for the same constituents as in the previous trial and the fire holding capacity was also ascertained. The results are reported in Table IV.

Table IV—Leaf Analysis (Trial III)

Treatments	*Levels*			
	0	1	2	
Potash K	0	125	250	*lbs. per acre as sulphate of potash*
Topping T	0	10	15	*level of topping*
Farm yard manure M	0	2	—	*tons per acre*

	Treatment K	T	M	*Ash Per Cent.*	*Nitrogen Per Cent.*	*Potash Per Cent.*	*Phos. acid. Per Cent.*	*Calcium Oxide Per Cent.*	*Magnecium Oxide Per Cent.*	*Chlorine Per Cent.*	*Nitrogen/ Potassium Ratio*	*Fire holding capacity (in seconds)*
1.	0	0	0	15·49	2·09	1·49	0·51	5·92	0·58	3·30	1·69	1·0
2.	0	0	1	16·62	2·04	1·61	0·51	5·66	0·63	3·50	1·52	0·3
3.	0	1	0	17·16	2·46	1·52	0·51	5·86	0·52	3·54	1·95	2·0
4.	0	1	1	16·94	2·27	1·62	0·51	5·77	0·73	3·13	1·69	1·0
5.	0	2	0	17·26	2·25	1·71	0·49	5·73	0·43	2·75	1·58	0·6
6.	0	2	1	16·93	2·35	1·79	0·50	6·20	0·33	3·32	1·58	0·3
7.	1	0	0	16·70	2·23	1·77	0·59	5·56	0·64	3·24	1·52	2·0
8.	1	0	1	17·51	2·21	1·77	0·54	5·72	0·39	2·90	1·50	1·6
9.	1	1	0	17·74	2·44	1·98	0·54	6·34	0·74	2·90	1·49	0·6
10.	1	1	1	17·47	2·54	1·96	0·53	6·20	0·43	2·93	1·56	0·0
11.	1	2	0	17·72	2·52	1·97	0·53	5·95	0·63	2·88	1·55	0·6
12.	1	2	1	17·85	2·54	1·97	0·51	6·09	0·34	2·96	1·56	0·6
13.	2	0	0	17·33	2·50	2·05	0·50	6·08	0·58	2·43	1·47	0·6
14.	2	0	1	17·61	2·32	2·07	0·53	6·05	0·38	2·50	1·35	4·0
15.	2	1	0	17·28	2·64	2·11	0·53	6·21	0·54	2·54	1·51	0·6
16.	2	1	1	1742·	2·66	2·10	0·53	5·86	0·44	2·57	1·53	1·6
17.	2	2	0	17·21	2·62	2·06	0·53	5·99	0·57	2·45	1·53	1·6
18.	2	2	1	17·50	2·49	2·11	0·51	6·14	0·43	2·55	1·42	2·3

A number of interesting facts appear to emerge from this trial, as regards the effect of each treatment :

Potash.

1. An increase in the nitrogen in the leaf with the increasing dosage of potash.

2. A similar increase in the leaf potassium.

3. A marked decrease in chlorine.

4. A slight decrease in magnesium.

5. A decrease in N/K ratio with the consequent improvement in fire holding capacity.

Cattle Manure.

1. A slight decrease in magnesium and a very slight increase in potassium.

2. A decrease in the N/K ratio and promotion of burning quality.

Topping.

1. The lower the level of topping, the greater the concentration of nitrogen and calcium.

2. The lower the level of topping, the greater the N/K ratio.

3. With no topping, the better the burning quality.

Although the percentage of nitrogen in the crop was not much affected, the increase in dosage of potash had brought about a progressive decrease in the N/K ratio. This coupled with the corresponding fall in the chlorine content had correspondingly improved the fire holding capacity. This is borne out by the favourable report from the Tobacco Company on the burning quality of the product from the present trial, whereas the report received on the samples from the earlier trials were quite unfavourable. A certain amount of improvement had thus been brought about, but the percentage of nitrogen and chlorine should further be reduced and potash increased to secure tobacco of good quality. Despite the certain amount of reduction in chlorine induced by heavy potash, it may not be possible under the conditions obtaining in the Peninsula, as already pointed out, to reduce appreciably the chlorine content of the tobacco. The aim in effecting improvement should therefore be directed towards lowering the nitrogen, lime and magnesia contents and increasing the potash. Besides the application of fertilizers, suitable crop rotation would go a long way in achieving the desired object. Future investigations will be carried out on these lines.

References

1. Schloesing, T. H. (1860) Uber die Verbrennlichkeit des Tabaks. Landw Vers. Sta. 3, p 98 (cited from 4).

2. Nessler, J. (1883) Dungungsversuche zu Tabak. Landw. Vers. Sta., 29, p. 309 (cited from 4).

3. Anderson, F. J. *et al.* (1930) Conn. Agric. Expt. Sta. Bull. 311, p. 228.

4. Attoe, O. J. (1946) Jour. Am. Soc. Agro. 38, p. 186.

5. Voltz, W. G. *et al* (1948) Soil Sc. Soc. Am. Proceed. 13, p. 385.

6. Darkis, F. R. *et al.* (1937) Indus. & Eng. Chem. 29, p. 1030.

7. Gribbins, M. F. *et al.* (1941) Jour. Agr. Res. 63, p. 31.

8. Johnson, J. & Attoe, O. J. (1944) Wis. Agr. Expt. Sta. Res. Bull. 153.

9. Garner, W. W. (1907) U. S. Dept. Agric. Bur. Pt. Ind. Bull. 105.

The Cultivation of Cacti and Succulents in Ceylon

E. W. RATNAWEERA

Introduction

In recent years the cultivation of cacti and succulents as window plants has gained popularity with amateur gardeners. It is proposed in this article to deal with their culture, propagation and pests and diseases.

Cacti and most succulents thrive in dry and arid conditions. They are excellent examples which are adapted to overcome extremes of heat or cold and lack of moisture. Most of them have no leaves at all and the functions of the leaf are taken on by the stem. Some are provided with leaves which are reduced to thick and waxy structures and in others leaves are replaced by spines. The stems take on various shapes to enable them to reduce the surface area exposed to the sun.

Most cacti are native to America while other succulents such as Euphorbias and Aloes are abundant in South Africa. The Sedums commonly known as the 'Stonecrop' are confined to cooler but drier regions of Europe. Examples of cacti indigenous to Ceylon are found in the *Rhipsalis cassytha* Gaertn. (Wal-navahandi S.) ; *Cereus grandiflorus* Mill. (Night flowering cactus E.) and *Opuntia Dillenii* Haw. (Prickly pear E., Katu-patuk S.) all of which thrive in the drier parts of the Island and are of Mexican or West Indian origin but naturalized to local conditions. Other succulents native to or naturalized to Ceylon are found in *Euphorbia Antiquorum* L. (Daluk S.) ; *E. Tirucalli* L. (Nava-handi S.) ; *Aloe vera* L. (Komarika S.), &c.

Cacti and succulents are fascinating, colourful plants though the duration of their flowers is short. They are excellent ornamental window plants varying in colour and not lacking in fragrance in certain types. Some of the *Ephiphyllum* Haw. varieties known as the 'Orchid Cacti' and the epiphytic climbing *Cereus* Mill. bear large and attractive flowers. The globular Mammillarias, Rebutias, Echinopsis, Lobivias and Gymnocalyciums serve as excellent pot plants which flower early. The majestic columnar Cereus and Opuntia varieties come into bloom as they grow older and Astrophytums, Lithops and Conophytums are curious-looking mimicry plants which imitate stones and such like objects around. They would hardly be noticeable in their own natural surroundings. Of the other succulents, the star-shaped Stapelias, Cotyledons, Echeverias, Sedums, Carallumas, Euphorbias and Huernias are of much interest.

Cultivation

Cacti can be grown successfully in a plant house with glass roofing, a sheltered frame or even on a window sill with little attention. The roof or frame should not leak. Cacti and succulents tolerate neglect to a greater degree than most other plants. They are

able to absorb and store large quantities of water enabling them to tide over long periods of drought without serious injury. It is important to note with care their periods of rest and growth. During the resting period cacti require very little water but as growth commences, watering once in three to four weeks will be necessary if the atmosphere is dry. In rainy weather watering should be restricted. It is better not to water in wet weather. The need for water is governed by the size of the plant and the pot in which it stands, for small pots dry more rapidly than larger ones and larger plants carry more stored up water. Once a plant is watered the excess water must be allowed to drain out fully. Watering is best done in the morning or late in the afternoon with water which has been allowed to stand for some time in a tub or tank.

The following potting mixture has been found satisfactory for cacti and succulents at the Royal Botanic Gardens, Peradeniya :—

1 part coarse, clean river sand
1 part sifted leaf mould
$\frac{1}{4}$ part crushed bricks
$\frac{1}{4}$ part crushed charcoal
$\frac{1}{4}$ part old potting soil
$\frac{1}{8}$ part crushed old motar rubble.

The compost mixture should be 'springly' and loose, falling apart easily when squeezed in the hand. Generally, a sandy soil with calcareous material is ideal, for cacti are lime lovers.

The method of potting is important. A concave piece of crock is placed over the drainage hold with the concavity downwards. The pot is now filled to about a quarter of its depth with crocks and brickbats of $\frac{1}{2}$–$\frac{3}{4}$ inch diameter. A layer of partially decaying, sterilized leaves is then placed over the crocks and the pot filled to about half with compost mixture. Then the plant is held firmly resting on the compost mixture, with its roots spread out and the pot filled all round with compost, at the same time tapping it on its sides. Care should be taken not to bury the plant too deep. A layer of coarse sand or gravel on the surface will give it a better finish. The first watering is done by immersing the pots in a vessel of water and allowing the water to seep into the compost through the bottom drainage hole. Small plants should not be potted in large pots and *vice versa*. The pot should always be in proportion to the size of the plant. Unlike other plants, repotting is not done regularly each year unless the pots are root-bound and the drainage holes blocked. Sickly plants that have not made much growth during the preceding year should be carefully examined for diseases and pests. They should be treated, cleaned and repotted. In repotting, clean pots should always be used along with freshly prepared compost mixture.

Propagation

Cacti and succulents can be propagated by seed or vegetatively. Propagation by seed is the best method of increasing stocks as seedlings gradually acclimatize themselves to their new surroundings. Although the process is simple the seedlings are slow in growth and a great deal of patience is necessary. Sowing is done in shallow earthenware pans 8–9 inches in diameter and 5–6 inches deep.

A two-inch layer of broken crocks is placed at the bottom over the drainage holes with a thin layer of partially decaying sterilized leaves and the pans are filled up to an inch from the top with the sowing mixture made up of the following :

1 part clean river sand

1 part finely sifted leaf mould

¼ part old garden loam.

A pinch of carbonate of lime added to the mixture will help to control to a certain extent soil borne insect pests. The compost mixture is sterilized before use by baking in an old tin or pouring hot water. The surface is now pressed down with a flat piece of wood to give it a smooth finish. Fine seed such as those of Rebutia, Cereus and Mammillaria is sown evenly on the surface and covered lightly with a thin layer of clean sand, while Opuntia seed which is large is covered upto 1/12th inch layer of the compost and a little sand sprinkled over. The surface is again pressed lightly with a piece of wood to keep the seeds firm. The seed pans are then labelled and watered by allowing water to seep through into the compost from the bottom until the surface is wet. The pans are removed and the excess moisture allowed to drain away. They are left in a shady position giving them the advantage of the morning sun. A sheet of glass covered with brown paper is placed over each pan until germination has taken place. The paper is then removed and the glass sheet raised a little on one side during the day to allow free circulation of air.

Although cacti need very little water it is important to see that the seed pans are never allowed to dry. It is best to soak the pans in water every fourth day in dry weather and seventh day during wet periods until germination has taken place. Overhead watering should be avoided. To prevent any fungus or algae appearing on the surface of pans a little 'Chinosol' can be added to the water. Most seeds commence to germinate by the seventh day and continue upto three weeks. It is also important to sow fresh seed as old seed though viable may take over an year to germinate. When germination is complete the seedlings are given more light and air gradually but not exposed to direct sunlight. When they are about 6 to 8 months old they should be carefully 'pricked out' into seed pans or individually into two-inch pots in a richer compost allowing more drainage. The general potting mixture already mentioned can be used for this purpose. The young seedlings are kept moist but not wet, for, if they happen to dry a red colouration will be noticed in the tiny stems and a considerable retardation of growth will result. Seedlings should be arranged on racks in a warm sheltered position allowing direct sunlight on them during part of the day. Seedlings will take from 4½ to 5 years to flower.

Vegetative Propagation

This method of propagation is resorted to when seeds are not readily available. Some varieties flower regularly but may not seed, and others take a long time to flower. Two methods of

vegetative propagation are generally adopted, viz. :

(*a*) Propagation by cuttings,

(*b*) Propagation by grafting.

Cuttings : In the method of propagation by cuttings three types of material are commonly used :

(i) Offshoots produced around parent plants, e.g., Mammillaria, Rebutia and Echinopsis

(ii) Leaves in the case of succulents, e.g., Sedum and Echeveria

(iii) Stem cuttings e.g., Cereus and Phyllocactus.

In practice, propagation by means of cuttings is adopted for three reasons :

(*a*) to multiply stocks quickly

(*b*) to replace old plants

(*c*) to save a plant in which the root or stem has begun to rot.

Cuttings are severed from the parent plants with a clean sharp thin knife so that the tissues may not be damaged. If cuttings are detached at a joint as in Opuntia the scar left will be small and takes less time to heal and the mother plant is less disfigured. Cuttings of Epiphyllum and Phyllocactus taken across the broadest part of the stem grow more vigorously and flower earlier. Cuttings, offshoots or leaves must be selected from healthy mature plants. These must not be potted immediately but stored in dry sands in partial shade until the wound has callused over. This takes place in 3–4 weeks depending on the variety. The cut surface may be dusted with charcoal, brick powder or sulphur dust to prevent rotting.

In most succulents cuttings need not be dried so long as prolonged drying may injure them. After two or three days the bases of these cuttings are inserted in a mixture of sand and leaf mould and left in partial shade until they are rooted and new shoots begin to appear. They can then be potted. The leaves may shrink to a certain extent immediately after but will be able to nourish the new plant.

In cacti when cuttings are sufficiently dry and the wounds callused over, they are inserted in a mixture of sand and leaf mould in shallow pans. The first watering is then given ; the second will depend on prevailing conditions and may have to be given even two or three weeks later. As far as possible only the soil must be watered without wetting the stems or leaves to avoid rotting. In the case of delicate varieties such as Euphorbias and Carallumas the same method may be employed, but a more ingenious way to promote rooting is to hang up the cuttings vertically and place a glass of water underneath, the level of the water being about an inch below the base of the cutting. This accelerates production of roots and avoids danger to them by rotting. Cuttings thus inserted take 1–2 months to root in the case of cacti and a few weeks for succulents. Once rooted they may be potted or planted in beds in a porous compost mixture. The same compost for potting mature seedlings is recommended. Plants raised from cuttings or offshoots mature and flower earlier than those from seed.

Grafting: Propagation by grafts is employed in the case of species which do not set seed readily or produce branches or outgrowths suitable for cuttings. The stock and scion should be of the same family and of uniform thickness. Stocks are selected from vigorous growing species. Both stock and scion must be fairly ripe but not too mature or woody. Two methods of grafting are adopted.

(*i*) *Cleft Grafting.* In this method a horizontal cut is made on the stock with a sharp, thin knife about 1½ inches above the soil level. A second cut to a depth of half an inch is made vertically through the middle, and the halves pushed apart gently so that it forms a 'V' shaped cleft. The scion is shaped into a wedge at its base by two oblique cuts and fitted into the cleft of the stock. The stock and scion are kept in position firmly by passing at the sides a spine of an Opuntia which is pulled out when the union is complete. The operation must be performed quickly to prevent the sap of the cut surfaces drying. The graft is now shaded with oil paper and left in the shade. Complete union can take place in 10 to 14 days, when the oil paper can be removed. It is important to keep the point of union absolutely dry when watering as rotting is otherwise liable to occur. Grafting can be done successfully with less casualties if the stock and scion are at the height of their growing period. Columnar species, after grafting, should be staked so as to keep them firm. Any growth from the stocks is not encouraged.

(*ii*) *Top Grafting.* In this method the stock is horizontally cut as above but no cleft made. A similar horizontal cut is given at the base of the scion. The scion is placed over the stock and kept in position by two spines of Opuntia.

Diseases

The most serious and common disease is rot, which commences at the base of the stem above the soil or at the root. It is probably due to incorrect watering and insufficient drainage. Watering should be done sparingly and that too when necessary only, by immersing the pots in water and allowing the excess water to drain off. It may be possible to save the rotting plants if detected in time. The infected basal portion is destroyed having removed the top. The cut surface is dusted with sulphur and dried until the wound is healed over. It is advisable to isolate such plants from the rest of the collection lest disease spreads. Old compost should not be used in repotting. All injured parts are disinfected with sulphur or perenox as a precautionary measure as the fungus normally enters the plant through an external injury. Watering should be restricted until the wound is healed.

Pests

Mealy Bugs: These are small insects covered with a white, woolly, waxy substance which protects them from most insecticides as they take cover in crevices and other inaccessible places. Plants should be examined regularly and the insects brushed off with a solution of nicotine sulphate or methylated spirits. Mealy bugs are also found to attack the roots of plants.

Such plants should be repotted after cleaning and disinfecting the roots with nicotine sulphate solution. It is important to use well decomposed leaf mould in the compost to avoid such infections from the soil. All staging and crevices which breed mealy bugs should be sprayed regularly with a suitable insecticide.

Scales: This is a common pest found on the stems and leaves. It appears in the form of small whitish shields. The pest spreads rapidly and should be controlled early. The scales should be removed by means of a hard brush dipped in nicotine sulphate solution.

Red Spider: This is an insect which is hardly visible to the naked eye. It appears under dry conditions causing a reddish, rusty, colouration and blistering of the stems. Plants infected should be sprayed with 'Derriphytan solution'. This is made up by mixing ½ oz. 'Derriphytan' in a gallon of fresh water.

Wood Lice: This insect is common in houses where wooden structures have been in use for some time. They feed on young seedlings and new growths. They are eradicated by dusting with gammexane.

White Ants (Termites): This is a serious pest in the tropics. A colony can destroy a valuable collection overnight. Damage done is hardly noticeable at the early stages, but in time plants begin to wilt and rot. White ants gain entry through the drainage holes in the pots and feed on the roots and the pulp. This is controlled by watering the soil with 'Intox 8' once every six months (1 oz. to 12½ gals. of water).

Caterpillars: In the ridges covered with hairs or spines of cacti, moths often lay their eggs. The caterpillars hatching out eat their way into the pulp. Through these injuries rot sets in if action is not taken in time. Plants should be examined regularly and the caterpillars handpicked and destroyed. Dusting with gammexane would be helpful.

Most pests and diseases can be avoided by the use of correct composts, proper drainage, careful watering and clean cultivation. Plants should be closely examined daily and prompt action taken at the earliest incidence of pest and disease.

Acknowledgments

I am grateful to Mr. D. M. A. Jayaweera, Superintendent of Gardens, for valuable suggestions and useful criticism and to Mr. A. Weerasinghe of the Propaganda Division for the photographs.

References

BERTRAND, A. (1953). Succulent Plants.

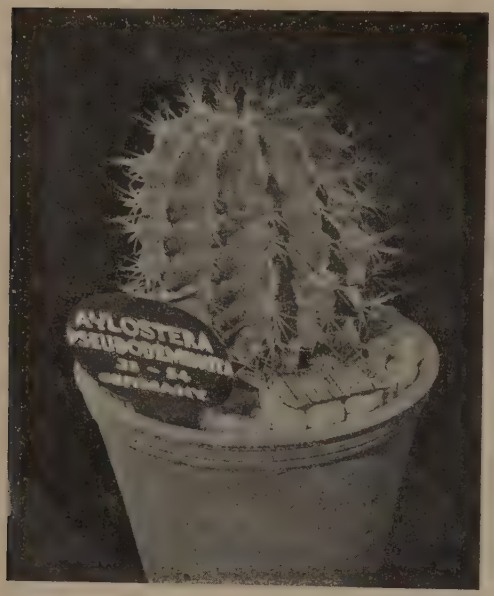
BORG, J. (1945). Cacti.

GREEN, G. GILBERT (——). Cacti and Succulents.

HIGGINS, VERA (1949). Succulent Plants Illustrated.

MACMILLAN, H. F. (1949). Tropical Planting and Gardening.

PARSONS, T. H. (1926). An Alphabetical List of Plants in the Royal Botanic Gardens, Peradeniya.



A plant of Aylostera pseudodeminuta

A group of succulents.

A plant of Weingartia Neumanniana
(*Spegazzinia Neumanniana*)

A group of cacti.

Queen Rearing with Apis indica

S. V. PERERA

One of the chief handicaps which prospective beekeepers of Ceylon are confronted with is the lack of readily available established stocks of bee colonies. This is not the case in western and other countries where beekeeping is often carried out on a relatively large scale.

Mr. C. Crozier, the octogenarian beekeeper, and possibly a few other beekeeping enthusiasts had successfully raised queen cells on a limited scale by grafting of young larvae, but did not exploit it on a large scale owing to their other commitments.

The most commonly used method for making artificial increase was the division of existing stray colonies during the active breeding season, namely, the honey flow season, and making use of the natural queen cells for making nuclei stock.

The chief disadvantage in this method is that colonies have to be disturbed during the normal honey flow season, which disturbs normal colony activities which affect honey yield.

Butler, during his assignment in Ceylon under the auspices of the Colombo Plan, adopting the typical grafting method used for *Apis mellifera* in the West, found that *Apis indica* queens could be as easily raised as in the West, using the colonies normally kept by Ceylon beekeepers.

Subsequently Baptist and the writer carried out queen rearing on an experimental scale in 1954 and this was continued by the writer in the honey flow season of 1955 quite successfully.

Although in the main the principles of procedure adopted are identical with those described for *Apis mellifera,* minor modifications and precautions are necessary on account of the differences in colony development and behaviour. In the present account a detailed description is given with special reference to the behaviour and handling of *Apis indica* colonies.

In this connection it may be mentioned that, in temperate regions, queen rearing is limited to either late spring or early summer conditions when drones are available in numbers for mating and colonies are in an active condition necessary for queen rearing work. On the other hand queen rearing of *Apis indica* can be done at almost any time of the year provided they are in a strong condition brought about normally or artificially, since *Apis indica* does not hibernate like its western counterpart. In the West this is offset by recourse to artificial insemination of *Apis mellifera* virgin queens, which however cannot be done with *Apis indica* at the moment owing to lack of suitable equipment.

The essential requirements for successful queen rearing may be listed as follows :—

(*a*) A very strong colony of bees consisting of 4 to 5 frames of bees and brood, together with a super full of bees and two to three frames of sealed honey. The queen of this colony should have been removed together with a comb of brood 48 to 72

hours prior to the colony receiving the frame containing queen grafts.

(*b*) Royal jelly obtained from developing queen cells of a colony mentioned above. The developing queen cells are cut off from the combs, the queen larvae inside them carefully removed, the jelly like substance surrounding the larvae is carefully removed with the aid of clean camel's hair brush on to a covered watch glass and stored in a refrigerator if not immediately used.

(*c*) A comb of brood containing larvae that are just hatched out and suitable for grafting. This comb of brood must be from a colony that has given a consistent good yield of honey and possess other desirable qualities such as disinclination to swarm excessively, &c.

(*d*) Grafting equipment. Artificial queen cell cups to receive the larvae, wooden blocks with depression in centre to hold cell cups, pointed and flattened wooden grafting needles for removal of larvae from the cells in the comb to the artificial cell cups, camel's hair brush to transfer royal jelly to base of artificial queen cell cups, empty frame with a wooden bar laid longitudinally across it to hold the cell cups mounted on the wooden box.

Preparation of Material

(*a*) *Making of artificial cell cups.* Pure bees-wax obtained from either comb foundation or piece of clean comb is melted in an open porcelain or glass vessel over a flame from a spirit lamp. Once the wax is completely melted the flame is either reduced to a small flicker or removed. A piece of wood which is rounded and tapered at one end as shown in photograph marked is dipped about half inch in the melted wax and kept for 3 seconds and removed. This stick is immediately dipped in cold water for a second and the cell cup obtained by removing it from the stick by a gentle twist of the fingers. This process is repeated till a sufficient number of clean cell cups are obtained, for example, about 15. Whenever the wax tends to become solid it is held over the flame till it melts. After all the cell cups have been made, the outer edges of each of the cell cups are cut to a height of 3/10th inch with a sharp blade which has been warmed over a flame to facilitate fine cutting.

(*b*) *Wooden blocks to hold the artificial cell cups.* These are made circular in shape out of ordinary packing-case wood, height being 5/10th inch and diameter 7/10th inch each. There is a tapering depression in about the centre of each block, the size of depression being 4/10th inch wide and 3/10th inch deep. A small panel pin or nail with a thin head 6/10th inch long is pierced through the wooden block so that 1/10th of an inch projects from opposite side to enable it to be pressed on to the horizontal bar in a frame.

(c) *Fixing of cell cups on wooden blocks.* The closed end of the cell cup is very lightly held to the flame of a candle and immediately placed on the centre of the depression in the wooden block, open end of the cell cup pointing upward. Generally eight such cell cups are mounted on the wooden block.

(d) *Fixing of the mounted cell cups on a horizontal bar and attaching it to an empty frame.* A 1/10th of an inch piece of wood 5/10th inch broad and 11 inches long is held together in position by two wooden rabbets from the top horizontal bar of an ordinary frame in the bee hive. This empty frame should not contain any comb foundation attached to it. The cell cups are now pinned with the open mouths pointing vertically downward. Generally speaking from 5 to 8 may be fixed to a cell bar, the number depending on the quantity of royal jelly available for transference into each cell cup.

(e) *Grafting needles.* These are made out of ordinary packing-case wood 1/10th of an inch thick, 4 inches long. One end is pointed to 1/16th of an inch whilst the other end is blunt.

The pointed end is used to lift the larvae and transfer them to the base of the artificial cell cups, the blunt end being used to widen the cell for removal of larvae from the comb.

(f) A few cc. of glass-distilled water should be available in a clean test tube for thinning the royal jelly if it hardens during exposure. Water distilled from a metallic container should not be used. The purity of distilled water should be 99 per cent. The grafting needles, the watch glasses, the camel's hair brushes should be thoroughly boiled in water and sun-dried before using. The cell cups fixed on the wooden blocks and mounted on the frame should be placed at least one hour before the actual grafting is done in the queenless colony to enable the bees to clean the cell cups of all dirt and foreign matter.

Guide to the selection of colony for raising queen grafts and comb from which larvae should be taken for grafting

As shown in the photograph the colony selected must be full of bees and brood and a super containing at least three frames of honey and a full complement of bees should be found. In a normal bee box of 6 frames, the brood box should at least contain 4 frames of brood of all stages (open brood and sealed brood), the super should contain a full complement of bees and at least 3 frames of honey.

Selection of Comb for removal of Larvae

A colony that has given at least five pounds of surplus honey and which has not exhibited excessive swarming tendencies and where a uniform rate of brood development has been noticed during the off season (honey flow season) should be selected. A comb containing newly hatched larvae (at least

about 15 such larvae) is removed, the bees are gently brushed aside, and taken away. It is preferable to avoid smoking this comb containing the young larvae. Once the comb is removed from the parent colony, the comb is wrapped over gently with a clean towel, till used for grafting, to prevent exposure of larvae.

Procedure of Grafting

(*a*) Time selected for grafting should be a clear sunny day, in an unexposed atmosphere.

(*b*) *Priming of the cell cups with royal jelly.* A blob of royal jelly is removed from the end of the camel hair brush and placed in the centre of each cell cup on the mounted frame. If the royal jelly tends to harden the camel hair brush is dipped in distilled water and moistened in the royal jelly. About 5 to 8 cell cups are thus given a blob of royal jelly. Generally at least 8 queen grafts can be successfully raised by a colony aforementioned.

Removing the larva from its cell in the natural comb to the artificial cell cup with the aid of the wooden needle

All open cells in the comb of brood are scanned. All cells containing larvae that are just hatched out to the larval stage are noted—this means the larvae that are just becoming concave in shape. The cells surrounding these larvae are flattened down by the blunt end of the wooden grafting needle. The pointed end of the grafting needle is inserted at an angle between the base of the cell and underside of the larva resting on the cell. The larva is lifted without injury and quickly transferred to the base of the artificial cell cup containing the royal jelly. The larva is deposited from the tip of the grafting needle to the centre of the royal jelly in the cell cup. This operation is quickly repeated before the royal jelly in the artificial cell cups dry up. During the time the larva is in the artificial cell cup it should be surrounded with royal jelly. After about 5 to 8 larvae are grafted the comb is placed in the centre of the colony that has been previously deprived of its queen.

Preparation of Colony to receive Queen Grafts

The colony selected should have five frames covered with bees and brood and the sixth frame filled with stores and bees. The super should also contain a full complement of bees and two frames of sealed honey. If this condition is absent naturally, it should be brought about artificially by one of the two following ways, namely, (*a*) artificial feeding of sugar syrup five weeks ahead of the proposed date of dequeening for requeening work. Feeding is done with half pound of sugar syrup every other day continually. (*b*) By the union of one or two colonies with brood and bees deprived of their queens to one colony with a queen. This is done as follows :—

> A colony which contains three frames of brood and bees is deprived of its queen at about 3 p.m. At about 6.30 p.m. or 7 p.m. when it is quite dark, this colony is placed on top of the colony that has to be strengthened. The queenless colony is deprived of its floor board and brood and placed on top of the brood box or super of the colony to be strengthened. The roof with crown board underneath is placed on top. At night the union of the two colonies will take place without any fighting. On the following day the

colonies would have mixed well and function as a single unit, and the bees and brood in the two brood boxes be transferred into a single brood box and a super placed on top of the brood box. If this colony is still short of bees to bring it up to the required strength for queen grafting a super full of bees containing bees and honey only from another colony should be placed on top of this strengthened colony at nightfall. Five days after union of colony, it is in a fit state for dequeening to receive queen grafts for rearing.

The queen is removed with a comb of brood on which she is found to another site 200 yards away to function as a separate colony if necessary. The colony now made queenless is examined after 48-hours and 72-hours respectively for presence of developing queen cells for removal. At the 48-hour examination queen cells would be found which are easily recognizable, as they are about half inch long and protruding outwards and facing downwards from the surface area of the combs. These queen cells should be cut out carefully with a sharp blade or scalpel as mentioned below and stored away in a test tube in a refrigerator, till royal jelly is required.

Preparation of Colonies to obtain Royal Jelly

At least five or six unsealed queen cells will be found in a dequeened colony at the 48-hour examination. These queen cells should be removed, by the aid of a sharp knife, with an extra cell surrounding the base of the queen cell to prevent crushing the larva in the queen cell whilst removing it from the comb. The mouth of the queen cells after the detachment from the comb should be enlarged with the blunt end of a wooden needle. The larvae inside the queen cells should be removed with the fine end of a needle without crushing and thrown away. The jelly-like substance surrounding the larvae should then be scooped out with the aid of a clean camel hair brush on to a watch glass, and quickly covered by another watch glass to prevent drying. This process is repeated till all the royal jelly from all the queen cells is collected. If the jelly tends to harden in the watch glass, a drop or two of distilled water is added by dipping the camel's hair brush in the distilled water and holding the brush on to the watch glass. The watch glasses are securely held together by a piece of twine or rubber band and stored away in a refrigerator. During the 72-hour examinations of the colony, if developing queen cells are found they should be removed and jelly collected. Royal jelly from 8 queen cells are enough from a single colony for priming five cell cups to receive the queen grafts. If royal jelly from 8 queen cells are not obtainable from a single colony during the 48- and 72-hour examinations, one or more of the other strong colonies should be dequeened 48 hours before the date of grafting for formation of queen cells to obtain the requisite quantity of royal jelly.

Examination of Colony for ascertaining number of successful acceptance of Queen Grafts

Twenty-four hours after the giving of queen grafts to the queen cell rearing colony, this colony is examined. The comb containing the grafts from the centre of the brood nest is taken out for examination. If bees are aggressive a little smoke from a smoker is administered to the tops of the frames in the

brood box. If bees have begun to draw out the queen cells by elongating them downwards, it is a sign that the queen grafts have been accepted. The frame containing graft is then quickly and gently replaced in its original place in the centre of the brood nest. The colony is not examined again till 8 days later, when all the accepted cells would be sealed as shown in photographs and ready for disposal to make up nuclei colonies of bees.

Removal of Sealed Queen Cells for making up of Nuclei Colonies and mating of Virgin Queens

On the 8th day the colony with the queen graft is examined for sealed queen cells. The number of sealed queen cells found are noted to make up the required number of nuclei mating stocks of bees and brood.

(*a*) *Making up of nuclei colonies, each nuclei colony to receive a queen cell.* Two frames of bees and brood and one frame of stores (pollen and sealed honey) are removed from the colonies that are in a condition to spare them into a nuclei box as shown in photograph. A sealed queen cell is removed from the cell bar by lifting it up. The bees surrounding the queen cell are blown off and the cell is quickly pressed on to the stores area in the brood frame so that it is in between the two brood frames and bees to ensure warmth. It is best that all the nuclei stocks are within 50 yards radius of the queen cells rearing colony so that the queen cells could be quickly disposed into the nuclei stocks without undue exposure.

The nuclei stocks are made up according to number of queen cells present. After all the nuclei stocks are each provided with a sealed queen cell, they are removed to the respective mating places.

(*b*) *Mating of virgin queens in nuclei stocks and susequent examination for successful mating.* The mating of the young queens must be by drones of colonies exhibiting desired characteristics such as high yielding and non-swarming tendencies. Colonies exhibiting these characteristics are noted and examined for presence of drones. If drones are found the nuclei colonies are brought and placed a few yards away from these colonies. The nuclei colonies may be arranged in a semi-circular fashion, the distance between being about 6 feet. If drones undesirable for mating are found in colonies in close proximity, they should be prevented from getting out by the use of excluder sheets which permit the passage of worker bees only. The excluder sheet is kept on till 10 days from the date of bringing the nuclei colonies to the mating area. It should be noted that no excluder sheets should be provided to the nuclei colonies in nuclei boxes.

Examination of Nuclei Colonies for signs of successful mating.

Fourteen days after the provision of the queen cells to the nuclei colonies, the colonies are examined for the presence of eggs or new larvae on the combs.

If eggs or larvae are found in the combs examined, combs are replaced. The nuclei colonies are examined again, a week hence from the first examination for eggs and larvae. Second examination is done to ascertain whether the open brood found at the first examination has turned into normal worker sealed brood. If at the second examination the sealed brood found is all that

will eventually turn out to be workers, the nucleus colony is transformed into a normal bee box and is ready for removal to its permanent habitation. A feed of sugar syrup should be given to the colony for about a fortnight at bi-weekly intervals to maintain a vigorous population of bees.

Results achieved

Degree of successful acceptance of queen grafts. Generally 60 per cent. to 80 per cent. degree of success was obtained. Lower degree of acceptance was obtained for any or combination of the following factors :—

1. Insufficiency of royal jelly for priming of cell cups.
2. Injury to larvae whilst removing from the comb for placement at base of artificial cell cup.
3. Over-exposure of larvae from time of removal from comb to placement at cell cup.
4. Septic conditions found in wooden grafting needle, distilled water, artificial cell cups. These conditions must be eliminated as mentioned earlier.

Degree of successful emergence of queen cells. 70 per cent. to 100 per cent. success was obtained. The following simple factors or a combination were responsible for the lower percentage of success :—

1. Time lag between removal of sealed queen cell and fixing on to brood frame in nuclei colony. This should be done almost immediately, in the neighbouring 50 yards of queen cell rearing colony.
2. The queen cell should not be exposed to extremes of heat or cold during its removal and transfer.

Degree of successful mating of virgin queens.

1. There should be at least 1 week of clear sunny weather from the date of emergence of the queen for her to mate.
2. Presence of drones within a radius of 25 yards during mating period.

Summary

1. Artificial multiplication of *Apis indica* queens for formation of nuclei colonies is quite feasible under conditions mentioned, using ordinary equipment.

2. Variations found in *Apis indica* could be exploited by multiplying such colonies by raising queen cells artificially to form separate off-shoots of the forest colony.

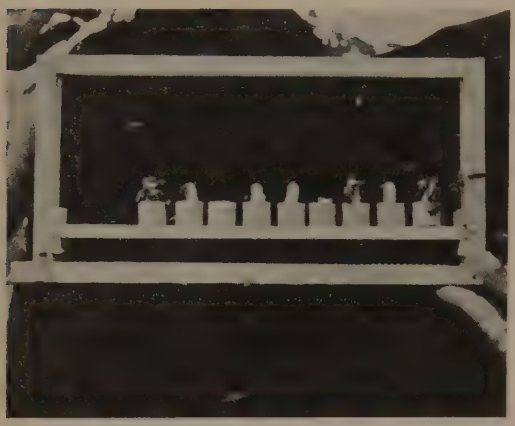
Acknowledgments

The writer is particularly indebted to Dr. B. A. Baptist for his continued help and guidance during the course of this work, and to Dr. H. E. Fernando, Entomologist, for providing all facilities for successful accomplishment of the work undertaken.

References

A report on the results of an investigation into the possibilities of beekeeping in Ceylon together with some suggestions for the future development of beekeeping in the Island. C. G. Butler, Bee Research Laboratories, Rothamsted, England, during his stay in Ceylon.

2. Unpublished data gathered from records in Entomological Division.



A frame with 7 sealed queen cells ready for removal to make nucleii stocks

A nucleus box containing a sealed queen cell amidst two frames of bees and brood.

1—Wooden block with depression in centre to receive artificial cell cup.

2—Wax cell cups fixed to wooden blocks and mounted on frame ready to receive larvae for grafting.

3—Camel hair brushes for removal of "Royal jelly" for priming cell cups before introduction of larvae.

4—Watch glasses for collecting and storing "Royal jelly" without drying.

5—Wooden grafting needles used in removing larvae from bowls to cell cups.

6—Stick for dipping into molten beeswax for making artificial cell cups.

Lifting young larvae from concave side with wooden needle.

DEPARTMENTAL NOTES

AGRICULTURE AFTER INDEPENDENCE

No ACCOUNT of agriculture in the Island since Independence will be complete without reference to developments in its three major agricultural industries, viz., tea, rubber and coconut. Nor will this survey be adequate unless it includes a review of Government's colonization policy and development schemes which have received highest priority since the inauguration of the Donoughmore Constitution. But as these subjects relate to the work of other Government Departments this article will be confined to features of agricultural interest with which the Department of Agriculture is primarily concerned. As food production which was one of its major functions has, since June, 1952, been shared with the Department of Food Production, some of the activities reviewed here will necessarily impinge on the work of the latter. But since the technical officers responsible for the execution of the food production programme are the Agricultural Officers and their staffs working in collaboration with the Director of Food Production and the Revenue Officers, such references will not be out of place.

Government has all along been fully alive to the great importance of increasing the food supply of the Island and to the necessity for making it largely, if not entirely, self-supporting in this respect. Every measure that could reasonably be conceived to promote food production has, therefore, been put into operation, such as the restoration of major and minor irrigation schemes and the construction of new ones, the establishment of colonization schemes, the provision of amenities to cultivators to obtain better crop yields and a fair price for their produce through the agencies of the Guaranteed Price Scheme and the Co-operative Agricultural Production and Sales Societies, &c.

Increased food production is being effected mainly through the agency of the District Agricultural Committee of which the Revenue Officer is the Chairman and the Agricultural Officer its chief technical adviser. The latter makes available to the Committee the advice and information which the Research Officers of the Department of Agriculture can offer on how crop yields can best be increased. The Committee is also guided in the framing of its development programme by the data which the agricultural extension officers in the District have obtained through demonstrations of improved practices carried out on cultivators' fields. Crops to which particular attention has been directed in the past are paddy, dry grains, root crops, chillies and onions. Prime among these is paddy in respect of which Government has guaranteed a minimum price of Rs. 12 per bushel. It also assists cultivators by subsidizing paddy fertilizers to the extent of one-third their cost if they are purchased through C.A.P. & S. Societies. The quantity of paddy fertilizer mixture sold to cultivators increased from a few hundred tons in 1950-51 to about 12,000 tons in 1955.

The Department of Agriculture provides cultivators with improved planting material, e.g., seed paddy, either from its own farms or through private seed farmers working in collaboration with it. The latter receive a premium of Re. 1 for every bushel of guaranteed seed sold by them to cultivators. Varieties of pureline seed suited to the various districts of the Island have been evolved or imported from abroad and tested out at our Experimental Stations. Forty-two such pure lines have now been issued and it is reckoned that about a third of the Island is now under them.

In other ways too Government has endeavoured to promote food production, e.g., by controlling pest attacks free of charge when these have assumed epidemic proportions or by providing the cultivators with spraying and dusting equipment for their control if the insecticides recommended are purchased from the C.A.P. & S. Societies. A Pest Control Service consisting of ten well-equipped vans, the gift of the Canadian Government, has recently been set up.

A new line of development in paddy cultivation which should have far-reaching effects is the introduction of machinery for

ploughing, harrowing, threshing, &c. This development has resulted from the establishment of six tractor units by the Department of Agriculture since 1950. These units undertake work for private parties at fixed rates and during 1953 over 15,000 acres of private land were cultivated. C.A.P. & S. Societies have since then purchased a number of tractors for the use of their members, and Government has also, either by gift or purchase, considerably increased its own quota of tractors. The total number of agricultural tractors in the Island may now be reckoned at over 800 of which the magnificent gift of nearly 200 tractors from the Government of Australia to Ceylon deserves special mention.

Government has also not overlooked the great importance of a sound land tenure policy for the promotion of improved agricultural production. The Paddy Lands Act introduced in 1953 is an example in point. Although this measure has been restricted to two Provinces for the present, its range of operation will be extended in due course where its need is felt to be greatest.

Because of the provision of all these amenities and of the intensification of methods of food production appreciably larger extents of land have been brought under food crops and yields per acre have also risen appreciably. To take the case of paddy again, it has been estimated by careful statistical surveys based on crop samplings, that the average yield of paddy in the Island is now about 30 bushels per acre per crop, depending on the season. This is a considerably higher yield than that reported in earlier records based on eye estimates by headmen. But there is little doubt that the yield of paddy, till comparatively recently, was appreciably lower than the present estimate. This is confirmed by the estimate of local production of rice now considered to be about 50 per cent. of our requirements, whereas in the not very distant past this was estimated at about a third of our annual needs.

If the tempo of improved methods of cultivation is continued during the next few years it is not unlikely that the average yield will be raised to 40 or 45 bushels per acre. This will be ensured if Japanese methods of cultivation, like transplanting in widely-spaced rows, weeding and intercultivation, the judicious increase of artificial manuring, the use of improved seed, and more efficient pest and disease control measures are adopted widely in the country. Results from trials with these methods have already proved very encouraging.

What applies to paddy applies to other guaranteed-price food crops, though to a lesser degree, e.g., onions, chillies and gingelly. Mention should here be made of the remarkable progress that has attended the cultivation of onions, particularly in the Jaffna Peninsula under a system of well irrigation, resulting in the local production of almost our entire requirements of this commodity. About fifty per cent. of the chillies we need is also now grown locally.

In regard to highland cropping in general, Government has recognized the necessity for developing a sound and settled system of agriculture to replace the wasteful chena cultivation on about 1½ million acres of unirrigable land available in the dry zone. For this purpose the Department of Agriculture, through the generosity of the New Zealand Government which has given a magnificent grant of £500,000, is establishing an up-to-date Research Station at Maha Illuppallama to study all aspects of the problem including animal husbandry in relation to rotational farming. A great deal of valuable information has already been obtained, necessitating a re-orientation of our ideas on the development of these lands. Reference in this connection should be made to the pilot dry farming colonization schemes which the Department has fostered at Kurundankulam, Relapanawa and Olukaranda in the N. C. P., following on the initial Kurundankulam experiment. These schemes have clearly revealed the factors limiting the adoption of a successful system of dry farming in these areas, and measures to counter them are being investigated.

Before leaving the subject of highland cultivation it is necessary to refer to the considerable development in the cultivation of cigarette tobacco in the Island as a result of the activities of the Tobacco Division of the Department and the co-operation of the cigarette-manufacturing Companies. From a negligible acreage a few years ago, over 5,000 acres of the crop were under cigarette tobacco in 1955. This has been largely due to

the provision of facilities for growing and curing, an assured market, and satisfactory prices for the product.

An important function of this Department is to advise on and ensure the adoption of soil conservation measures, whatever the type of agriculture practised. A Soil Conservation Act was passed in 1951 and is now being operated. Under the regulations of this Act the greater extent of the Island's tea acreage is now a declared 'erodible area' in which the soil conservation measures prescribed are rendered obligatory.

On the animal husbandry side of its work, the Department has much cause for satisfaction, particularly with respect to its animal breeding farms. These farms which have been established in various parts of the Island to supply good quality stock to breeders for grading their livestock, are not only performing this essential function but have become an important source of supply of pure milk to hospitals and milk feeding centres. The total quantity of milk produced from our farms during 1955 exceeded 600,000 gallons. It is also gratifying to record that these animal husbandry farms are nearly all paying their way. Our extension activities in animal husbandry have been intensified by the formation of livestock societies in the districts to promote the production of milk, eggs and other livestock produce. The creation of the Milk Board has induced greater milk production. Additional veterinary services have also been provided in various parts of the country through free dispensaries, and inoculation and artificial insemination campaigns.

A review of this nature will be incomplete without some reference to the research activities of the Department both in the agricultural and animal husbandry fields. Though research personnel has not been increased to any appreciable extent in the last few years, marked advances in research findings have been recorded. Fundamental research on crop varieties and agronomy, and applied research on their nutrition and the control of pests and diseases have provided information of considerable value to agriculturists, while investigational work on animal breeding and disease control has also given useful results.

Agricultural education has formed a major activity of this Department for many years now, but during the past five years a new policy of training women, in addition to men, in agriculture was initiated and is now firmly established. There is a major agricultural school for women at Kundasale and three practical schools in other parts of the country. About 250 women receive a training in these schools both in agricultural subjects as well as in home science in order to befit them to play their part in the regeneration of the rural womanhood of this Island. It is planned to establish agricultural day schools as well as residential schools for both men and women in the near future and to increase the number of all types of agricultural schools so that every Province will be adequately served for training its young men and women in agricultural pursuits.

No account of agricultural development during the past six years could omit reference to Government farms of which there are at present 50 units comprising experiment stations, schools farms, seed and plant supply nurseries, livestock multiplication centres, &c. These units are not primarily commercial, but have been established to serve certain essential functions which any Agricultural Department is expected to undertake. During the past few years a new policy in regard to their management has been adopted and several were closed down which did not serve the purpose for which they were intended. It is gratifying to record that the ratio of revenue to total expenditure (including capital expenditure and expenditure on research) on all these units has increased from 29 per cent. in 1947-48 to 82 per cent. in 1953-54. Expenditure during this period dropped from Rs. 7.6 to 5.6 million and revenue increased from Rs. 2.2 to 4.7 million.

Before concluding this review mention should be made of a new extension activity which this Department is fostering in the firm belief that this will prove to be a fruitful means by which the gospel of improved methods of cultivation could most effectively be disseminated in the country. The Young Farmers' Club movement has within the short space of three years already gained a

strong foothold in the Districts. There are today over 500 Clubs with a membership exceeding 25,000.

The years since Independence have witnessed a marked intensification of all aspects of agricultural enterprise with which Government has been concerned. In this work it has received the full co-operation of all classes of agriculturists. As a result of this joint effort much has been achieved, but much remains to be done. If this public support is continued in full measure in the future and Government and its officers do their part, the Island will soon see a rapid advance of agricultural production, particularly in its essential food supplies.

A. W. R. JOACHIM,
Director of Agriculture.

THE ATOM IN THE SERVICE OF AGRICULTURE

OCCASIONALLY THE announcement of startling new discoveries in agricultural research makes it appear that man's ability to increase the world's productivity has bounded forward in a sudden unpredicted leap. The truth usually is very different. Behind each successful advance lies a long sequence of slow and careful steps, and striking practical benefits cannot be expected within a few years of the introduction of a new tool, however powerful, into the workshop of research.

Radioactive tracers are no exception to this rule. It is barely a decade since they were first applied widely in agricultural research and we are still only beginning to reap the benefits of their use. Their potential value is, however, already clear.

Study of Plant Nutrition

They enable us to make many types of observations which hitherto were impossible or very difficult. The study of plant nutrition provides many such examples. If a nutrient "labelled" with a radioactive isotope is introduced into a plant, and proper safeguards are observed, it behaves in exactly the same way as if the label were not present. However, because of its radioactivity, the "label" can be detected by means of a Geiger Muller counter connected to suitable equipment.

Individual atoms make their individual records as they emit radiation, and quantities of labelled substances, infinitely smaller than those detectable by ordinary chemical means, can be measured. Moreover, the measurement is not affected by the presence of other substances which may cause difficulties in chemical analysis. But this is only one aspect of the advantages of tracers. A labelled substance can be distinguished from unlabelled but otherwise identical material absorbed before or afterwards.

For example, in some studies of the manner in which plants utilize phosphate, the behaviour of the phosphate absorbed in a single day has been followed for several weeks during which the plants were absorbing ordinary unlabelled phosphate. In this way an understanding of the changing manner in which plants utilize nutrients can be gained. In other experiments the great sensitivity of the method has enabled it to be shown that within a few minutes of entering a growing plant phosphate is converted into complex substances.

Visual Records

Similar experiments, but with labelled substances placed on leaves, have enabled progress to be made in developing ways of feeding plants by spraying and thus avoiding the complicated reactions which fertilizers may undergo in soil.

Because photographic and X-ray films are sensitive to radiation they can be used to give visual records of the position of labelled substances. Pieces of tissue containing labelled substances are placed in contact with films and "radioautographs" of the distribution of the radioactive substance are obtained. Many investigators have used this method to discover how different substances are distributed in different parts of root, leaves and fruits. It is even possible to reveal the positions in which substances are accumulated within individual plant cells. Unfortunately these methods cannot be used in the study of the manner in which plants

use nitrogen, one of the most important nutrient elements, for it possesses no suitable radiocative isotope. The majority of the other important plant nutrients can, however, be studied in this way.

To the agriculturalist, the behaviour of the plant is not one part—though the most important one—of his study. The soil which varies so greatly from place to place in its ability to provide plant food presents him with many major problems. For example, he wishes to understand why plants are able to absorb only very small quantities of fertilizers, particularly phosphates, from some soils.

"Isotopic Exchange"

Until recently the behaviour of these "phosphate-fixing" soils was largely unknown. Now radioactive phosphorus is providing new information. Advantage is taken of the phenomenon of "isotopic exchange". If a soil or another substance containing largely insoluble phosphate is placed in a phosphate solution, phosphate ions are exchanged between the solid and the solution. This process can be measured with great simplicity by tracer methods and the results provide information of an entirely new type on the forms in which phosphate is held in soil. When plants are grown in soil to which labelled phosphate has been added, additional important information can be obtained.

The use of radioactive tracers in agricultural research is, however, by no means confined to plant nutrition. Selective herbicides, which have been so greatly used in recent years, are sometimes effective in killing weeds, without damage to crop plants, when they are applied at the rate of a few ounces per acre. Their action is being studied with the aim of providing means for dealing with weed problems which are today unsolved. The minute concentrations in which herbicides are effective made it impossible to measure accurately the extent to which they are absorbed or converted into other substances, until tracer methods could be used. Radioactive atoms are introduced into the molecule of the herbicide for this purpose.

The entomologist who is interested in the movement of insects, not molecules, gains a similar benefit by feeding insects on labelled food. He can then follow their migration in populations of unlabelled insects.

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CACAO SUBSIDY SCHEME

This scheme, which is sponsored by Government, was formulated with the object of underplanting cacao in those marginal rubber areas over 1,200 feet in elevation in the Kandy, Matale and Badulla Districts which are suitable for that crop.

The Whitelaw-Perera Rubber Commission, whose report was published as a Sessional Paper in 1947, recommended that no replanting of rubber should be permitted in areas over 500 feet in elevation. But as the owners of rubber lands at higher elevations, mainly in the Kandy, Matale and Badulla Districts, had also contributed to the replanting cess, Government authorized the Rubber Controller to issue a few replanting permits for replanting lands in these areas in 1953, 1954 and 1955. Although only a small area was replanted the results were not encouraging. The Rubber Replanting Board therefore recommended to Government that lands situated at elevations of 1,200 feet or more should not be eligible to participate in the Rubber Replanting Subsidy Scheme and the owners of such lands should be granted subsidies for planting cacao and other crops which are more suited to the higher elevation.

The Cacao Subsidy Scheme is therefore intended to operate from 1956 onwards only in those marginal areas 1,200 feet and above in elevation in the Kandy, Matale and Badulla Districts which are considered to be suitable for cacao by the Department of Agriculture.

Amount of Subsidy and how payable

The subsidy approved by Government is Rs. 350 per acre. This amount is considered to be adequate as the grower will continue to

obtain an income from the rubber while the cacao is coming into bearing.

The subsidy is payable in five stages as follows :—

(1) After clearing the land between the rubber trees, fencing and holing—Rs. 70 per acre.

(2) After planting cacao seed or seedlings in baskets and establishing primary shade of crotolaria and wild sunflower—Rs. 70 per acre.

(3) In the second year after the cacao plants have been thinned out to one per hole and are of satisfactory girth and height—Rs. 70 per acre.

(4) In the third year after the plants are well established and manured —Rs. 70 per acre.

(5) In the fourth year after the rubber is gradually thinned out and replaced by permanent shade of dadap or albizzia—Rs. 70 per acre.

Persons eligible for the Subsidy

Owners of rubber lands 1,200 feet and over in elevation in the Kandy, Matale and Badulla Districts which are considered by the Department of Agriculture to be suitable for growing cacao are eligible for the subsidy. Applications for cacao subsidy permits will be called early in August, 1955, and particulars of the registered extents, ownership, &c., will be checked in consultation with the Rubber Commissioner.

Variety of Cacao

Ceylon cacao is of the Trinitario type which produces the "fine or flavour" cacao of commerce. Being an admixture of Criollo and Forastero it does not generally breed true to type from seed, and consequently there are wide variations in the pod size, colour, shape, &c., between trees. The colour of the pod may vary from deep red to greenish yellow, and is no indication of the variety. The exquisite quality and flavour of the Trinitario cacao is even thought to be due to the natural blending of the various strains which constitute the Trinitario type. Some of them set pods with own pollen, while others are self-sterile and require cross-pollination for satisfactory pod set. For these reasons it is recommended that if bud-grafts are planted they should be polyclonal.

Source of Planting Materials

Cacao seed does not generally retain viability for more than a day or two after extraction, and has to be therefore planted with the minimum of delay.

Pods for seed extraction will be obtained as far as possible from selected trees in approved plantations within the district during the major cropping season in October-November each year. Arrangements will be made for the registration of these approved plantations and supply of pods from selected trees during the season for seed extraction and planting.

Method of Planting

Planting is best done with the early North-East Monsoon showers in October. Holes 1½ feet deep and 1 foot in diameter should be dug and filled with a mixture of top soil and cattle manure or compost at the rate of one or two baskets per hole. The holes should be in rows between the existing rubber trees at an optimum spacing of about 12 ft. × 12 ft. but the spacing may be varied from a minimum of 10 ft. × 10 ft. to a maximum of 15 ft. × 15 ft. depending on the distance between the rubber trees.

Two to three seeds should be planted in each hole at a depth of one inch and the seedlings which germinate should be thinned out to one per hole when they are five to six months old.

Seedlings in baskets may also be planted in place of seed, in which case the plants should be raised in advance from seed extracted from the spring crop in May-June.

Shade

Optimum shade is essential for the satisfactory growth of cacao. Shade produced by seedling rubber will be of the right inten-

sity if the canopy is not severely thinned out by Oidium, while the shade of budded rubber may in the case of certain clones such as PB 86 be too heavy for cacao and cause it to remain stunted.

Primary shade is provided by planting *Crotolaria brownei* in contour rows about 6 feet each side of the cacao plants. Contour rows of wild sunflower may also be planted at wide spacing between the rows to provide green material for mulching the cacao plants.

In peasant holdings where intensive cultivation is possible the planting of bananas as secondary shade for cacao is recommended if there is sufficient space between the existing rubber trees. Gliricidia may also be planted for that purpose.

Permanent shade of dadap or *Erythrina lithosperma* or *Albizzia sumatrana* should be established gradually as the cacao comes into bearing so that it may replace the rubber in course of time.

Manuring

The basic dressing of 2 to 3 baskets of cattle manure or compost should be followed by an application of a balanced fertilizer mixture containing Sulphate of Ammonia, Superphosphate and Muriate of Potash in the following proportions :—

Sulphate of Ammonia ..	100 parts
Superphosphate ..	75 parts
Muriate of Potash ..	25 parts
	200 parts

About 2 to 3 lb. of the mixture should be applied to each plant one foot from the base and forked in lightly without damaging the roots.

The cattle manure or compost should be given just before the drought sets in in June-July, and the fertilizer mixture with the early rains in late September or October.

Pruning

Cacao needs pruning from the start if it is to be productive, but in the first year pruning is confined to the removal of all shoots that arise below the crotch or "jorquette" formed by the main stem. The jorquette consists of a framework of lateral or "fan" branches in which the leaves are arranged in a single plane in two rows. Erect growing "chupon" branches in which the leaves are arranged spirally are also produced, but they should not be allowed to grow from the main stem in the early years since they will branch out and form a second storey which will retard the setting of pods on the lower framework.

Diseases and Pest Control

The young plants should be protected from attack by leaf-eating caterpillars and other pests by spraying with D. D. T. emulsion concentrate at the rate of about 1 oz. per 2 gallons of water.

Phytophthora disease which causes stem canker and black pod is contolled by spraying with a copper fungicide at the rate of 1 oz. per gallon of water.

Soil Conservation

Adequate measures should be taken to prevent the loss of valuable top soil by erosion. Contour drains and bunds should be provided at suitable intervals, and on steep slopes there should be individual terraces for the trees.

Fencing

Damage by stray cattle is often the cause of failure to establish cacao under rubber. The area to be planted should be fenced securely with 4 strands of barbed wire, using cut rubber branches as fence posts initially, and Gliricidia or arecanut later in wet weather to form the permanent live fence.

Inspection

The *First Inspection* will be made by an accredited officer of the Agricultural Department or a Visiting Agent to check on the extent of the rubber land and determine its suitability for underplanting cacao.

If the land is found suitable the applicant will be given the necessary advice regarding the lining and preparation of holes and establishment of primary shade for cacao. He will be entitled to the first instalment of the subsidy after the land is cleared and fenced and the holes for planting cacao are prepared.

The *Second Inspection* will be made after the cacao and primary shade have been established. The second instalment of the subsidy is payable at this stage if the work has been done satisfactorily.

The *Third Inspection* is done in the second year after the cacao plants have been thinned out to one per hole and manured with the fertilizer mixture. The third instalment of the subsidy is payable at this stage if the plants are of satisfactory girth and height.

The *Fourth Inspection* is made in the third year after the plants are well established and manured. The fourth instalment is payable at this stage if there are no vacancies and progress is satisfactory.

The *Fifth Inspection* will be carried out after the permanent shade of Dadap or Albizzia has been established and the rubber thinned out gradually. The final instalment of the subsidy is payable at this stage.

Budgrafting in situ

Besides local clonal selections, limited quantities of the following clonal planting materials introduced from Trinidad, West Africa, Indonesia and New Guinea about two years ago after a satisfactory period of quarantine at Kew and Heneratgoda will be made available as budgrafts and rooted stem and leaf cuttings for multiplication on estates which are issued with permits for underplanting in cacao :—

From Trinidad .. ICS 1, 6, 8, 16, 39, 40, 45, 60, 84, 89, 95, 98.
PA 7, 35.
NA 32, 33, 34.

From New Guinea K 6, 16, 19, 21, 24, 26, 27, 28.

From Indonesia .. DR 1, DR 2, DR 38 and G 8.

From West Africa West African Amelanado.

The performance of the above clones, many of which are reputed to be high yielders with a potential yield of over a ton of cured cacao per acre in their countries of origin, is being studied under local conditions. If they come up to expectations budwood may be removed from them for budgrafting the underplanted cacao *in situ*.

BOOK REVIEWS

Sampling Theory of Surveys with Applications—By Dr. .P. V. Sukhatme

THE MOST striking feature of Dr. Sukhatme's book is the staggering amount of algebra that it contains. This, in itself, is likely to be forbidding to any lay reader. But it is well to remember the objectives of the book, viz :—" to serve the needs of a text for teaching an advanced course in sampling theory of surveys and of a reference book for statisticians entrusted with the planning of surveys for collecting statistics ".

Curiously enough, the introduction of a large volume of algebra was necessitated by Dr. Sukhatme's attempt to simplify the whole edifice of modern Sampling Theory. Algebraic proofs of complex mathematical theorems always tend to be tedious in the extreme and there is the possibility that the student may not be able to see the wood for the trees. The proofs, however, are set out in an extremely lucid manner.

From the theoretical standpoint, the most valuable section of the book is Chapter X which deals with " Non-sampling Errors ". This aspect of sampling has received little emphasis by Western writers. However, it is this component of error which is relatively large in surveys conducted in under-developed countries of South East Aia, and Dr. Sukhatme rightly stresses its importance.

The various applications of the theory are of fundamental importance. The examples are taken from various surveys conducted mainly by Indian statisticians both in India and elsewhere. These include many conducted by Dr. Sukhatme himself. The agricultural background of these surveys is so similar to that obtaining in other under-developed countries that it is possible to adopt the techniques almost in toto.

In Ceylon, where so far no objective evaluation of agricultural practices has yet been made, it is to be hoped that Dr. Sukhatme's techniques would be closely followed.

P. K.

An Annoted Bibliography of Rice Soils and Fertilizers—Commonwealth Bureau of Soil Science, Harpenden, England, and Food and Agricultural Organization of the United Nations, Rome, Italy. 1954—$1.50 or 7*s.* 6*d.*

THE LITERATURE on rice, of the last decade, is replete with examples of the ignorance of the results of earlier investigations. This is not surprising, for the literature on rice is voluminous, is widely scattered, and often is not accessible to the average research worker. The Commonwealth Bureau of Soil Science and the F. A. O. have done a signal service to the cause of rice research by collecting, annotating, and publishing nearly a thousand references—many of them from obscure and inaccessible publications—on rice soils and fertilizers.

The references are arranged under the heads : Soils, Cultural Operations (including irrigation), and Fertilizers (including mineral nutrition). These main sections are divided into sub-sections in which the references are arranged in chronological order and, within any year, alphabetically, according to the authors' names. The compilers must be commended for having brought together so much information in so orderly and assimilable a form in so small a space.

The bibliography is fairly complete for the period 1929-53 and includes a few earlier references. It is unfortunate that the compilers saw no way of bringing in references to the classic researches of Pearsall and Mortimer on lake muds—researches which more than any others have contributed to our understanding of the chemistry of flooded rice soils. Among the inaccuracies in the annotations, the most serious is the complete reversal of Van Raalte's finding on the oxygen supply of rice roots (page 10, ref. No. 55).

This publication, along with Kuilman's " Rice during and after the War ", should be the constant companion of every worker in the field of rice research.

F. N. P.

CROP PROTECTION—BY C. J. ROSE—LEONARD HILL LIMITED, LONDON, 1955—223 PP., 113 ILLUSTRATIONS—30S

THIS IS a book written in popular language on a subject of considerable interest today in all agricultural countries of the world. While little attention is devoted to other methods of crop protection however, the entire emphasis is on the chemical aspects of crop protection. This book therefore consists of a popular rendering of the subject of agricultural chemicals and the machinery available to disperse agricultural chemicals in a manner so as to achieve maximum results in crop protection. The book is divided into four sections. In section 1, following upon a brief review of the general principles of crop protection, the author plunges into the subject of chemical crop protection from the second chapter onwards. Chapters II and III give an account of the basis of chemical formulations of agricultural chemicals and the principles underlying the choice of formulations to be used in crop protection. In section II, Chapters IV, V, VI, VII and VIII provide in about 60 pages a simple summary of the inorganic and organic weedkillers, insecticides, fungicides and rodenticides available today for use in crop protection. Section III covering chapters IX to XII gives a good account of the various types of simple and complex machinery available for the application of chemical formulations in crop protection. Hand-operated and power-driven dusting systems, high volume and low volume spraying systems, aerosol projectors, soil injectors and flame throwers are dealt with in this section which is concluded with a chapter on the choice, operation and maintenance of equipment. Section IV briefly covers the subject of storage of crop harvests. This book will be of special value to those seeking an introduction to the subject of crop protection by the application of modern chemical methods.

H. E. F.

CENTRAL BOARD OF AGRICULTURE

PROCEEDINGS OF THE TENTH MEETING OF THE CENTRAL BOARD OF AGRICULTURE HELD AT THE SCHOOL OF AGRICULTURE, PERADENIYA, ON AUGUST 22, 1955, AT 2.30 P.M.

Dr. A. W. R. Joachim, Director of Agriculture, presided, and the following were present :—Mr. C. A. M. de Silva, Vice-Chairman; Mr. G. V. P. Samarasinghe, C.C.S., Director of Rural Development; Mr. N. Manicka Idaikkadar, C.C.S., Director of Food Production; Mr. S. Arumugam, representing the Director of Irrigation; Mr. T. C. Rajaratnam, C.B.E., J.P., U.M.; Mr. A. Hensman; Mr. W. M. Cumaraswamy; Mr. S. L. Bandara Dharmakirti; Mr. S. Sivapalan; Mr. R. H. de Mel; Gate Mudaliyar N. Wickremaratne; Mr. S. Srinivasan; Gate Mudaliyar Arthur D. S. Jayasinghe; Mr. Henry Abeywickrema, M.P.; Dissawa S. A. I. Elapata, M.B.E.; Mr. A. M. Clement Dias; Mr. Ray Wijewardene; Mr. G. B. Portsmouth, Director, Tea Research Institute; Mr. K. Kanagaratnam; Mr. P. B. Bandaranayake; Mr. Gladwin Kotalawala, M.B.E., M.P.; Mr. B. L. W. Fernando, Commissioner for Development of Marketing; Mr. Albert Godamune; Mr. S. A. Selvanayagam, O.B.E.; Mr. S. Thondaman, M.P.; Mr. A. G. Divitotawela; Mr. M. B. Samarakoon; Mr. T. B. Naranpanawa; Mr. R. B. Thalakada, representing the Commissioner of Co-operative Development and Registrar of Co-operative Societies; Mr. S. Vythilingam, M.P.; Senator (Mrs.) Clodagh Jayasuriya; Mr. N. H. Keerthiratne, M.P.; Senator Lady Adeline Molamure; Mr. R. T. Chelliah; Mr. M. Atkinson; Mr. Kenneth Morford; Mr. H. A. Pieris; S, James P. Obeysekera; Major E. C. de Fonseka; Mr. C. J. Strachan; and Mr. N. P. Wijeyeratne, C.C.S., Secretary.

The following visitors were present by invitation :

Dr. T. M. Z. Mahamooth, Deputy Director (Animal Husbandry) and Government Veterinary Surgeon; Dr. M. F. Chandraratne, Assistant Director of Agriculture (Technical), Mr. A. V. Richards, Chief Research Officer, Mr. G. V. Wickremasekera, Divisional Agricultural Officer, and Mr. T. Wickremasinghe, Soil Conservation Officer.

Letters and telegrams regretting inability to attend the meeting were received from the following:

Mr. R. Singleton Salmon, C.B.E., M.P.; Mr. Charlie Edirisuriya, M.P.; Mr. C. Wijesinghe; Mudaliyar M. M. Ebrahim, M.P.; Mudaliyar Abul Cassim Markar; Mr. K. W. Devanayagam; Mr. U. B. Unamboowe, M.P.; Senator E. W. Kannangara; Mr. D. B. Ellepola; Mr. G. K. Newton; Mr. J. M. Sabaratnam; Dissawe Sydney Ellawela; Senator Sir Sangarapillai Pararajasingham; Dissawe H. B. Rambukwelle, M.P.; Sir Wilfred de Soysa; Mr. R. H. Spencer Schrader; Mr. A. D. Paranavithane and Senator Thomas Amarasuriya.

I—Confirmation of the Minutes of the last Meeting

The minutes of the previous meeting of the Central Board of Agriculture were unanimously confirmed.

Mr. A. Hensman pointed out that although he was present at the previous meeting of the Board his name did not appear in the minutes.

The Chairman regretted this omission which he said was possible if Mr. Hensman had not signed the attendance list.

II—Matters arising from the Minutes

(i) Mudaliyar S. Armstrong's resolution moved at the 8th meeting of the Board on January 21, 1955, *re* purchase of earth-moving tractors and scrapers by Government to undertake levelling of paddy-fields on a hire-basis system.

Chairman—" This matter was referred to the Ministry and the reply we have received from the Director of Food Production is as follows :—

'S/A & F. has recently ruled at the Mechanical Advisory Board Meeting that this is not a function of this Ministry.' "

(ii) Mr. Ray Wijewardene's resolution moved at the 8th meeting of the Board on January 21, 1955, *re* the broadcasting of a regular weather forecast, etc.

Chairman—" This matter was referred to the Director of Meteorology and this is what he says in a letter to his Permanent Secretary :—

' I do not propose to take any action until the Central Board of Agriculture forwards a copy of the resolution to Government with a request that it should be implemented.

2. I do not think the present state of knowledge of tropical meteorology will justify our attempting forecasts for periods much longer than 24 hours until the matter has been investigated. There is at present no margin of staff with me to undertake such studies. The question of the necessary additional staff will be taken up when the request from the Central Board of Agriculture is received. '

Chairman—" I think it is indicated that we should forward this resolution to Government and until that time no further action can be taken. I, therefore, propose to draw the attention of the Minister and ask that some action be taken. "

(iii) Mudaliyar S. Armstrong's resolution moved at the 8th meeting of the Board on January 21, 1955, regarding the opening of suitable sand bars on the borders of the Batticaloa lagoons to prevent damage by floods to paddy lands.

Chairman—" This resolution was forwarded to the Government Agent, E. P., with a copy of the minutes. But for some reason or other the G. A. has not been able to reply. The resolution was sent on the 1st June and another letter was sent on the 1st August but up to now we have had no reply.

I would now read a letter I have received from Mudaliyar Armstrong " :—

' I have the honour to request you to kindly excuse my absence from the 10th meeting of the Central Board of Agriculture to be held at Peradeniya on Monday the 22nd instant as I am unwell and advised by the doctor not to travel long distances.

With regard to my resolution (1) (iii) appearing in the Agenda for discussion I shall be obliged if you will kindly place this before the Board and the President, the desirability of requesting the Government Agent of the Batticaloa District to form a Committee consisting of the Divisional Irrigation Engineer, the Executive Engineer, P. W. D., the Divisional Agricultural Officer, E. D., the Chief Engineer (Irrigation), Gal Oya Development Board and the mover of the motion and one or two others interested in the proposl to formulate a scheme as suggested by the President at the eighth meeting of the Board, supported by the Assistant Director of Irrigation and agreed upon by the mover.

Re (1) (i) it is a matter for all concerned and the Director of Food Production will be able to put the matter more forcibly to the Board for a final decision please. '

Mr. N. H. Keerthiratne, M. P.—" Sir, can't you send this resolution to the District Co-ordinating Committee ?

Chairman—" Yes, I shall send it on to that Committee. "

(iv) Mr. Ray Wijewardene's resolution moved at the 9th meeting of the Board on May 2, 1955, *re* the conversion of sewage and garbage into organic manure for sale to planters and farmers.

Chairman—" I wrote in this connection to the Director of Health Services, the Mayor of Colombo, the Municipal Commissioner, Colombo, and to the Director of the Industrial Research Institute asking them to do whatever they could to implement this resolution. I have had a reply from the Municipal Commissioner to this effect :—

' With reference to your letter of the 1st instant addressed to the Director, Industrial Research Institute, General's Lake Road, Colombo, copies of which have been sent to the Mayor of Colombo and the Municipal Commissioner, we are now investigating this in connection with the proposed refuse disposal plant to be constructed at Madampitiya.

We have already received some particulars from manufcturers of this type of plant from Denmark and European countries.

These will have to be given careful study before we make a definite recommendation to Council. '

" The Director of Health Services has also replied to this effect :—

' With reference to your letter addressed to the Director, Industrial Research Institute with a copy to me, I have to inform you that necessary technical advice will be given (if called for) by local M. Oo. H.

I have also to request you to consult the Superintendent, Health Services, of the respective areas where such advice is necessary.

I have not had a reply as yet from the Director of the Industrial Research Institute. There is, at the moment, a World Health Organization Conference in Kandy dealing with this subject. I understand that discussions on this subject were completed last week. This matter could not be taken up earlier as there was no date fixed for the discussion of this particular item. Meantime I wrote in to Mr. Wijewardena asking him to contact the D. M. & S. S. as the subject was being discussed at the W. H. O. Conference. I am told that Mr. Wijewardena too has been informed that this subject had already been discussed at that Conference."

III—Discussion of the Report of the Minor Products Sub-Committee on Cacao

The Chairman requested the Chief Research Officer, Mr. A. V. Richards, to speak on the subject.

Mr. A. V. Richards—"Mr. Chairman, Ladies and Gentlemen, this Report was submitted at the last meeting when I gave a brief resumé of the position arrived at by the Sub-Committee on Agricultural Minor Products. It was then proposed to discuss the Report at the next meeting. The recommendations of the Committee are that marginal rubber lands of 1,200 feet elevation and over in the Kandy, Matale and Badulla districts should be considered for under-planting in cacao. For that purpose the Committee reported that a subsidy of Rs. 400 per acre should be given to the grower. Since then Government has gone into this scheme and has favoured the proposal of paying not Rs. 450 but Rs. 350 per acre, because it is felt that growers would derive some income from the rubber for the first three or four years or so. They therefore felt that Rs. 350 would be an adequate subsidy.

The other proposal of the Sub-Committee was that in the same way as for Crown land is to be made available for planting tea, rubber and coconut a scheme should be devised for planting Crown land with cacao, and that the necessary subsidy should be given for this purpose. It has been proposed that Rs. 750 would be an adequate subsidy for planting Crown land with cacao.

The third proposal was that any private land belonging to villagers, if found suitable for cacao, should be planted with cacao. The Sub-Committee has recommended a subsidy of Rs. 450 for this purpose.

Those are the three proposals put up by the Sub-Committee and action has already been taken to implement the first recommendation that marginal rubber lands of an elevation of 1,200 feet and over should be under-planted in cacao. Applications are now being called for from prospective growers. The land would be inspected and an officer would be appointed to advise on the suitability of the land for planting cacao and for providing the necessary subsidy. The subsidy is payable in five instalments of Rs. 70 each. The first and the second instalments will be paid during the first year. When the land has been cleared of weeds and depending on the progress of the plantation, the other three instalments will be paid. This action has been taken on the first proposal recommended by the Sub-Committee."

Mr. Ashmore Peiris—"May I please know whether there will be sufficient planting material to be issued under this new scheme of planting cacao?"

Mr. Richards—"We have imported certain varieties and we could supply the required quantity of planting material after multiplication."

Gate Mudaliyar N. Wickremaratne—"This Committee has a big name as the Minor Products Sub-Committee, but they are taking up cacao plantation which is not a minor product. There are several minor products which have not received any attention so far. The other thing I wish to point out is that the Horticultural Officer of the Department should be made to concentrate on fruit cultivation instead of cacao. These schemes of replanting rubber and cacao have taken away even the few fruit trees we had. I know of an instance where several mangoosteen plants had to be cut down to make room for rubber. Planting of cacao was started over 50 years ago all over the country, but today a subsidy is also recommended for growing more cacao. We should concentrate more attention on fruit crops which are lacking in this country."

At this stage the Chairman stated: "Mudaliyar, I think you might leave this matter to the Committee which is a Sub-Committee of this Board. They have gone into the matter fairly exhaustively, and have chosen twenty crops including cacao, coffee, cinnamon, citronella, cotton, cardamoms, cloves, cashew, papain, pepper, tobacco, sugar cane and fibre plants for study. They have excluded what are normally known as food crops, as these are looked after by the Food Production Sub-Committee of this Board. I quite agree that the Horticultural Officer should devote his time to the study of fruit cultivation and I should say that he has devoted adequate time to this subject. But

the Hon'ble the Minister has requested that the Horticultural Officer should devote some of his attention to the subject of minor products as well. This being a Ministerial direction of policy, I think you will agree it has to be carried out."

Mr. C. A. M. de Silva, Vice-Chairman—" If the person concerned had requested that the mangosteen plants referred to by Mudaliyar Wickremaratne be allowed to remain, it would have been granted, because when they demarcate these boundaries, ten perches are allowed for any fruit trees or useful trees that exist."

Major E. C. de Fonseka—" It will be very helpful to those participating in this scheme if prices of planting material are also given along with the other particulars."

Mr. Richards—" Selected pods are sold at 25 cents each. Each pod will have 35 to 40 seeds. That is enough to plant 20 holes. As for the clonal material, we have not yet fixed the price. We have imported clones from Trinidad and other places, and the prices of these will be reasonable."

Chairman—" May I take it therefore that we proceed to item 3? Incidentally I would like to say that the Agricultural Minor Products Sub-Committee will continue to issue reports from time to time."

Mr. Richards—" We have just issued a report on Coffee."

IV—Report of the Paddy Advisory Sub-Committee

Chairman—" Dr. Chandraratne is the convenor of this Sub-Committee but he is not here at the moment. But there are a number of other members in this Committee including Mudaliyar Armstrong, Mr. Clement Dias, Mr. Godamune, Mudaliyar Wickremaratne and others. In the circumstances I would like to know whether Mr. Godamune would kindly summarise the report ?"

Mr. Albert Godamune—" Ladies and Gentlemen —the report submitted and circulated to the Board is really a summary of the discussions that took place at the several meetings of the Sub-Committee that we had. What we all felt and wanted to stress on this Board was the importance of concentrating on the paddy production of this Island for various reasons, the chief of which was that Ceylon's economy would always be unstable till that day is reached when we can say that we do not depend upon imported rice.

Secondly, all what we have done and have been doing in the past has not produced the results which the country so badly requires. For this reason a new solution should be worked out immediately. We have touched on that point in this memorandum and for the present we have limited ourselves to one part of the Island as you would see in the report, and that is to paddy fields in the wet zone of the Island. The Sub-Committee is dealing with the other part of the Island and we hope to submit those recommendations in a second instalment. As regards the wet zone paddy fields you will notice that we have stated that there are about 450,000 acres under cultivation or supposed to be under cultivation. In this connection we would like to draw your attention to the fact that bringing new land under cultivation has not solved the immediate food problems. That programme will not, within measurable distance, solve the problem a solution to which is immediately required to make the country economically sound. There are 900,000 acres of land already asweddumised. For about 25 to 30 years we have been neglecting these and concentrating on major works and trying to solve the problem by bringing new land under cultivation. With all the expenditure that Government has incurred, the time that has been taken, over 25 to 30 years, you will notice that the total acreage of additional asweddumised land is only 50,000 or 60,000 acres. On the one hand we have 40,000 to 60,000 new acres of paddy land brought under cultivation after 30 years of work at an expense of, may be millions of rupees. On the other hand we see that 900,000 acres of paddy that already existed being neglected and left to look after itself with no assistance from Government. The thirty years of work and the money spent on major works have by no means gone waste. It has met various different problems but has signally failed to reduce except in a very small way the difference between what we produce and what we import. But, taking a short-term policy, the Sub-Committee feels that more could be achieved by concentration and paying special attention to the 900,000 acres of paddy aleady existing. Now the question is why this 900,000 acres of paddy did not produce as much as it should, and why the production was so low ? The reason assigned for it so long has been that the cultivator, the individual concerned, the human element was deficient. You must have read reports and heard people say that the village cultivator is so backward, so primitive, that he does not take to new methods and as a result production had kept low. But the Sub

Committee feels that this was not the real reason for this low production, but that there is some other reason. That something else was not known by those handling the matter. It is really a matter that goes back to history. Why this 900,000 acres did not produce what it should was spotlighted by the International Bank Report which state in this connection that the irrigation arrangements for these paddy fields are deficient. So does the U. K. Australian Commission on Rice Production in Ceylon. We have not realised and we have overlooked the fact that these paddy fields had been deliberately destroyed on two occasions, when there were two rebellions, one in 1818 and the other in 1848. This destruction can be proved by reference to documents of the period. Facts are available for reference to the state of the paddy industry before these rebellions.

You all must have read and know very much about Robert Knox's book on Ceylon. He has made some very observant remarks in which he has referred to the carefully organised irrigation works that were built on the hill-sides, little tanks, little irrigation works by which water was available to the cultivator when he required it. In other words, paddy cultivation, according to the way it orginally worked, was not dependent on regular rain. Whether the rains came regularly or irregularly, the peasants continued their cultivation operations unhampered because they depended on their small tanks or 'pathahas' from which water was available. I need not remind these gentlemen, I suppose most of them are aware, that paddy being a 6 months plant, it has to be sown at the correct time when the water is available, then water has to be drained off at the correct time, and so on. All these operations were timed and arranged. Such a system existed in the past. The damage that was caused to the paddy production of this Island in the year 1818 was considerable. We thought that it would be unfair to make mention of it in the report as we might be misunderstood. I do not blame anybody, but these facts date back to the origin of the decay of this industry. Day who was in charge of the North-Western Province says that large extents of rice fields were completely destroyed. Referring to Badulla District in the Uva Province, the report says that cultivation had completely ceased to exist in this province. These are instances to show what extent irrigation works were destroyed in order to destroy paddy cultivation to subdue the country. There was another rebellion in 1848 where the same policy was adopted and as a result we have got acres and acres of paddy land, 900,000 acres, for which the irrigation is defective. The scorched earth policy followed to repress the rebellions caused terrible damage to village irrigation.

The other day Dr. Chandraratne gave us an opportunity of meeting some Japanese experts. We questioned them about the Japanese method of transplanting and they answered us. Their answer was that all their transplanting and all what they do in Japan on paddy is entirely dependent on a properly organised system of irrigation and by giving the paddy cultivator facilities by which he can turn in the water any time he wants it and turn it out any time when he considers it not necessary. These Japanese methods of paddy cultivation about which we have heard so much are all dependent on proper irrigation facilities to every paddy land and to every paddy cultivator in the country. At the same time I told them that the present deterioration in the paddy industry was not due to the deterioration of the human element but due to the deterioration of the physical element in the way of irrigation facilities, and the neglect of this industry for several hundred years on the part of the Government and the Irrigation authorities, in the maritime and the Kandyan provinces. They entirely agreed. In the Kandyan provinces this neglect has been only for about 150 years and nothing has been done up to date in the way of repair except for a little thing here or a little thing there. You will be surprised to hear from my friend from Uva, Mr. Divitotawela, that there were fields from time immemorial in that province which were cultivated twice a year or once in three years and sometimes once in five years. This is because the little village tanks that fed these fields are either in a state of disrepair or completely broken down and destroyed. Unless action is taken to restore these damaged village tanks, I do not think that even for centuries we would be able to solve our food problem. It is therefore necessary that we will have to pin-point public attention and remedy what was not remedied for over 100 years. Then only will we be able to solve the problems that are involved in paddy cultivation and at the same time be able to raise the peasant's standard of living and put him back on his feet once again.

Before I conclude I would like to say that the note we have made here gives only a very concise account of the measures recommended by the Sub-Committee. One of the recommendations—recommendation (12) of the Sub-Committee was the establishment of a Paddy Rehabilitation Board for the wet zone. The U.K. Australian Mission

on Rice Production in Ceylon say in their Report that the Government and the industries concerned, that is tea, rubber and coconut have seen fit to set up special Research Institutes for the three major industries of the Island but yet there is no specific organization exclusively for the improvement of rice. The Mission has recommended the establishment of a separate Rice Improvement Unit in the Island, and I am sure you are aware that arrangements are being made for establishing such an Institute. I think the Chairman told me that even money has been passed in the Budget for this project. But my view is that rice research is one thing while rehabilitation of the paddy industry is another. Rice research is a very good thing and we want the institute established but in addition to that we want a Paddy Rehabilitation Board established for rehabilitating the industry. Gentlemen, you will understand that we will have to take range by range in this matter and see whether the storage tanks are there and whether the storage tanks have a small catchment and whether the water coming from these tanks are channelled properly and so on. I have seen everywhere that certain channels due to neglect have been widened and that there are no proper anicuts. What the cultivator now does is to improvise some method to get his water by blocking it with coconut branches, etc. He somehow improvises some devise temporarily to get over his difficulty. I know of another method these cultivators adopt in the North-Western Province, along Maha Oya. Soon after floods, the cultivators block the water by using coconut leaves, coconut husks and shells, and before the flood water drains off to the river they quickly do their sowing. Sometimes till the next floods come they are unable to do any cultivation. Unless these matters are attended to, our food problem cannot be solved.

You will see in this report certain extracts from a previous Paddy Committee appointed in 1928 or 1929. In that they pin-point the various bits of irrigation that should have been carried out. I think you gentlemen will like to know that the late Mr. D. S. Senanayake was one of the members of that Committee. This report says :—

" We do not hold the view experienced cultivators of paddy are in any way ignorant of the benefits of tillage and of the application of manures. The principle of seed selection and transplanting has has been long known to the cultivators and has been practised by them for ages. The defect *is in the irrigation* which has been neglected for years." That report givs various suggestions to be followed. Then the Kandyan Peasantry Commission Report in 1952, in regard to the Central and Uva Provinces gave a schedule of a number of minor irrigation works that should be carried out, the cost of which was estimated at less than Rs. 5,000 each. In these two Provinces, the minor irrigation works should be attended to immediately. These works have not been attended to as yet because no single Government Department has taken the entire responsibility for it. Now it is supposed to have been given over to the Home Ministry. What we want to stress is that this work is so wide that it will have to be taken up province by province, district by district and village by village and trace out the defects in irrigation of each bit of paddy land. That means considerable work and it also means much time. In order to reduce the time involved in this matter to a minimum and for co-ordination we have suggested the creation of a Rehabilitation Board. If this Rehabilitation Board is entrusted with the rehabilitation of these 450,000 acres in the Wet Zone it will solve our problem to a great extent If this rehabilitation is done through a Board the cost will be comparatively less. Today money is being spent on various projects through District Agricultural Committees, Government Agents and on recommendations of the Central Board of Agriculture, International Bank, etc., and several millions are spent on major schemes. But you will realise that 50 per cent. of the items recommended in the Kandyan Peasantry Commission Report will cost less than Rs. 1,000 each and the balance will cost less than Rs. 5,000 each. From this you will get an idea of what the actual cost will be.

I submit this Report of the Sub-Committee on behalf of Dr. Chandraratne and ask for your indulgence for the time I have taken on this matter and I request your consideration in regard to the proposal to establish a Rehabilitation Board to rehabilitate the existing paddy fields in the Island. "

Chairman—" Now Gentlemen, the Report is before you and I would like to have any observations you wish to make on the proposals. "

Mr. T. B. Naranpanawa—" Mr. Chairman, Ladies and Gentlemen—I have gone through the Report of the Sub-Committee and I find that item (9) of the measures recommended needs modification. I think it is not practicable to restore old 'wana-athes'. Old 'wana-athes' should be maintained but new 'wana-athes' should be established.

There is another matter to which I would like to make reference and that is with regard to the actual improvement to the destroyed irrigation

works which Mr. Godamunne particularly pointed out, and nobody would deny the importance of restoring them. At the moment the existing practice is that every year Government Agents are given a certain allocation for this type of work and with the assistance of the technical staff attached to the Government Agent, the items put up by the District Agricultural Committee are carried out. Perhaps it is felt that the pace at which this work is carried out is too slow. The importance of the subject is so great that we do not see results fast enough. But even if a Paddy Rehabilitation Board is established, it would be pertinent to ask what the administrative machinery would be to get the work done. If it is going to the same technical men, the establishment of a Board would not make much of a difference. In the alternative, how is it possible to get the men to implement the recommendations of the Board ? I think there should be a Sub-Committee of this Board to recommend these measures or else you will have to think of the administrative machinery.

Mr. G. B. Portsmouth,—" I would like to know what part the Irrigation Department plays in the matter of minor distribution of water ? "

Mr. S. Arumugam (representing the Director of Irrigation).

" In the case of minor irrigation works, the Irrigation Department does not come in at all, it is the Revenue Officer who comes in. "

Gate Mudaliyar N. Wickremaratne—" Old ' wana-athes ' or new ' wana-athes ' will depend according to the situation of the paddy tract. Ninety per cent. of the old ' wana-athes ' may be there, and if there are no old ' wana-athes ' new ' wana-athes ' will appear.

As regards the machinery necessary to implement this work, I think Mr. Godamunne himself said that the Government and the Paddy Committee will go into this matter of providing the necessary personnel. "

Mr. Ashmore Peiris—" I think he has mentioned a large number of factors in connection with the economic production of paddy. I think the chief question is the water problem. In 1912 a Paddy Rehabilitation Board was suggested. With the present set-up the Food Production Department and the Government Agents doing this work, one wonders what exactly a Rehabilitation Board could do except to look into the question of irrigation. As far as I know every year the question of irrigation is looked into by the Government and the District Agricultural Committees as a chief item. I know that they go into this subject and draw up a priority list. For minor irrigation works the Government Agents are given an allocation and the D. R. OO. look into the question of minor irrigation works. So that with the Food Production Department doing the propaganda part of it and the Government Agents looking into the other questions, mainly irrigation, I think a set-up like this would be a very costly one. I do not know how exactly this would function, as the duties would overlap. "

Sir James P. Obeyesekera—" What is the Japanese method of planting paddy ? At Kandawela the other day at the demonstration we had there, I think the Japanese Ambassador said that their ownership is one-fourth acre or under so that their methods would not entirely suit us. I think the Siamese or the Burmese method of cultivating paddy would be very profitable. The methods they adopt are of course very elaborate. They have elaborate irrigation methods which we do not have. Large tracts are not cultivated owing to the lack of labour. We do not have a labour class here for paddy cultivation. Our village population has got to do it. It is very difficult of course to cultivate large extents of paddy with the present peasant population. "

Mr. Kenneth Morford—" Since Mr. Godamune first brought up this matter some years ago in the Nuwara Eliya D. A. C. we have been able to get all the water channels attended to and I think I may say that at the end of each season there is a decreasing number requiring further attention. The policy of Government Agents carrying out minor irrigation works, in conjunction with the advice of the D. A. CC. has been very successful in speeding matters up where small schemes are concerned.

There are many important matters in this report to thich I would like to refer, items 3 and 6 about catchments and forest reservations. Due to lack of timber and a somewhat careless issuing of permits to fell timber these stream reservations are being denuded of timber and this in turn causes silting up of channels. I think the existing machinery, rightly used, will bring very rapid restoration of all the channels. "

Sir James P. Obeysekera—" Minor irrigation works are all executed but there is none to maintain them. Village people cannot be expected to maintain them. "

Mr. S. Arumugam (representing the Director of Irrigation)—" Mr. Chairman, Ladies and Gentleman —this report on the cultivation of paddy has definitely become a subject more of irrigation than

of paddy cultivation. In any case, Gentlemen, I intend touching on one or two points extempore as I listened to the implications of the report, given by Mr. Godamunne. First of all, admittedly, the country's development during the last 400 years was not primarily focussed on paddy cultivation. There was development certainly but the accent was not essentially or primarily on paddy cultivation. And now you Gentlemen cannot expect the Irrigation Department from that situation to bring it up to such a stage as other crops had been brought up to. As the speaker himself explained, there are over 9 lakhs of acres under cultivation. During the first Six Year Programme, over 82,000 acres of new uncultivated virgin land were opened up for paddy cultivation. This figure is very large indeed. Well, it appears in the Administration Report and other official documents. Subsequently we have combined a programme and we are working towards that end of attaining 20,000 new acres for irrigation development with paddy cultivation. Twenty thousand acres is our ideal which is set before us per year. We may not keep it every year but over a period of six years, I am sure we will. Now Gentlemen, these are figures, let us have them in their proper perspective. We have, as given in the Report, 9 lakhs of land already under cultivation. That was so before the First Six Year Programme was announced. What is the extent of Ceylon ? It is only 16¼ million acres. Deduct from it the area that is required for natural reserves. If we deduct this area, then we are left with 2¼ million acres. So that the position is that we had 9 lakhs of acres already under cultivation before the first Six Year Programme. During the First Six Year Programme we did very well in opening up 82,000 acres. For the next Six Year Programme our target is 20,000 acres per year, but we have only 2¼ million acres invariably for paddy cultivation. So gentlemen, you would now see my point in bringing this as an explanation to what was pointed out in the Report, that extensive cultivation is the solution to our problem. Today we simply say that extension of cultivation is very essential, but how far can we go, till.....is reached which is the ideal.

However efficient Irrigation Engineers may be, they cannot do anything more than what has been done. They cannot do the impossible. They cannot be expected to find water on hill-tops and cultivate the lop sides.

The other point, Sir, is about how irrigation has gone into disuse and abuse. I will not attempt to deny it. If we go into the detailed working of each irrigation scheme, I daresay there will be many weak spots. But I would suggest one overall solution which will help and may even put matters right because it is found so in other countries. I believe Gentlemen, that this is the only country in which irrigation water is supplied ad libertum—so liberally—i.e., just opened up. The cultivator or the consumer of the water is not required to pay in proportion to the amount of water consumed. India charges for the water consumed. England is doing so, Australia charges, Japan is also doing so. I have yet to find a country with proper irrigation practices where water is just supplied and the consumer is not required to pay by the amount of water consumed. Many of the abuses would be solved when a man is taxed according to the quantity of water consumed. You ourselves as practical agriculturists may point to this, that the moment there is a shower of rain the cultivator would send an urgent message requesting that the sluice be blocked. If he is charged for the water he consumes, he would be economising his own supply, or he may start dry sowing, and inducement may be there for him to conserve the water. That I think will probably be an overall solution to many of the abuses and the problem connected with what you mention.

Gentlemen, the other point is just a small one, about the Kandyan Peasantry Commission works. All these have been put on a priority list and where the work is of a very small nature, Government Agents are doing it. Where the work is of a bigger nature, the D. A. C. and the Irrigation Sub-Division is doing it.

The next point is about minor irrigation works and repairs and improvements to minor irrigation schemes. As the Irrigation Department is called upon to do these various schemes of development, naturally the country's demands on the Irrigation Department is focussed on the major schemes and more of our staff is engaged on them, because we have to produce about 20,000 new acres every year. Smaller schemes, Government Agents are expected to execute this work and in cases where they have difficulties, the Irrigation Department seconds the services of a technical officer.

Mrs. Clodagh Jayasuriya—" I would like to ask what part women can play in the work of paddy cultivation in Ceylon. In Japan, I noticed that women went into the field and did all the light work while the men were engaged on harder work. In this country also are our schools teaching our girls to get into the field and do this work ? If they do that I think it will be a good thing and they will have an aptitude for this type of work."

Mr. Henry Abeywickrema—" Mr. Chairman, Ladies and Gentlemen—if we are to attain self sufficiency in our food we will have to step up our intensive cultivation. Our depending on extensive cultivation will never solve the problem, as a previous speaker pointed out, a time will come when we will finish all our available land. The time is not very far. At the present rate of 30 to 40,000 acres a year, in ten years' time we will not be able to do extensive cultivation. Owing to the fact that our population is increasing rapidly, we should concentrate on intensive cultivation. Let us see how far we have succeeded in the last ten years. I am glad that the Food Production Department is taking a lot of interest in this matter. Though they are doing a certain amount of good work, I feel that the speed at which this work is going on is not enough. Now, how are we to attain this higher yield of paddy cultivation ? My friend Mr. Godamunne stressed the importance of irrigation facilities. That alone will not do. Any expert will agree that there are five important factors for successful paddy cultivation. These five factors are,—good seed paddy, either pureline or some seed of good quality, adequate application of manure, a sufficient supply of water and keeping the field free of weeds. Do we adopt all these ? How many of our cultivators implement these ? If we want to get a higher yield in paddy, it is very necessary that all these factors should be attended to. It is not enough to adopt one or two of these measures. For instance, if manure is applied and the rest is neglected, you cannot expect a yield.

Today all our people are talking about the Japanese method of paddy cultivation and accounts of it appear almost daily in the papers. What is this Japanese method of paddy cultivation ? About 90 per cent. of our people are interested in these Japanese methods of paddy cultivation. Gentlemen, this Japanese method is, transplanting in a row which most of our people are already aware of. What I want to say is that you should take more interest in paddy cultivation and try and improve on the existing yields as otherwise as the population increases, in another ten or fifteen years we will have to starve. We should as far as possible discourage extensive cultivation and concentrate on intensive cultivation.

Now Sir, going into average yields of our country, according to Dr. Ramiah's Report our yields are 13·4 bushels. That works out to about 26 bushels per acre per year. That is one of the lowest yields in the whole world. We are getting sufficient paddy in this country to keep the present population fed for 2½ days a week. Therefore if we are to be self supporting in paddy we have to increase our production at least by 1·35....? That is not difficult because I am personally aware of people in this country who have got over 50 bushels. In 1953 I had the pleasure of working out a plot of two acres of paddy and I got 55 fold. I have read in the papers certain gentlemen getting 84 and 94 fold. If we get an average of 30 fold, we will be self-supporting. Anything over can be exported. From what I have read, in Japan the plots of paddy are very much smaller. We cannot get better results in our country because of absentee landlords. We expect that the newly introduced Paddy Lands Bill will solve the problem, but it has not much effect on the cultivators. "

Mr. G. V. P. Samarasinghe, Director of Rural Development—" Mr. Chairman, Ladies and Gentlemen—the report seems to indicate that irrigation is the main difficulty. The question of land tenure is in my experience the basic problem that causes most of the trouble. The question of ownership of land, leasing of land rights and how shares are taken, these are the problems that really matter. I have known areas in a district in which the workers had to buy their right to cultivate at an auction. The system is called the *madaran* system and people have to bid for the right to cultivate the land. I am afraid that the existing system did not assist the actual man who is cultivating. A worker in a district and the average cultivator would like to have the assurance that he would be able to cultivate the same block of land year after year. It is this problem of ownership where a cultivator is not sure that he would be able to cultivate the same field in succession that has to be solved. Unless you solve that you will never get a chance of intensifying paddy cultivation. I know that there is a Paddy Lands Act but will the Act have any actual effect in the rural areas ? Secondly facilities should be given to the cultivator to acquire an intensified agricultural training, a more detailed knowledge of techniques and a more scientific knowledge of practices. Go down to the field and find out from the cultivator to what extent he understands the principles behind these techniques and/or to what extent he merely does it because the Agricultural Instructor or the Food Production Officer has told him. He merely does it because someone has told him. I feel that a vast majority of cultivators do not know the reasons behind these techniques. Methods of

persuasion as for instance 'Wap-magul Ceremonies', etc., are necessary and these mean certain things but the problem has to be solved more basically. Each farmer must know what he is doing. If you take the estate economy a tea plucker or a rubber tapper must know his job. If you want to get your estate established well your rubber tapper must know what he is doing. If the paddy cultivator is to produce intensified yields much more information and much more scientific knowledge should be imparted to them before we can hope for any appreciable results from intensification. I saw somewhere a statement that there was not enough labour. My own personal point of view is that there is a surplus of labour. These are their difficulties: One man does not cultivate a land for more than one season. The owner is in a position to dictate 'If you do not do this as I want I will change my cultivator'. This indicates that there is enough labour rather than an actual shortage of labour for the agricultural operations in the country. These are the three points I want to make. My experience in the field is that unless these things are done any amount of work will not be helpful or give positive results. You take a place where there is 100 per cent. irrigation. Take the N. C. P.—the Parakrama Samudra—where you get fine yields but even here you do not get 100 per cent. cultivation for two seasons, as it is too much for an individual cultivator to cultivate intensely, his lack of scientific knowledge and the techniques of cultivation. Mainly, however, I feel a solution should be found for the ownership of land and the rights of cultivators."

Mr. N. Manicka Idaikkadar, Director of Food Production—"I am grateful for the paper that has been prepared, but I am a little disappointed because we have seen a lot of these reports in the past and my greatest worry is to keep abreast of them. We have had very little time for philosophy. I would like when reports are prepared that people come down to earth. The first point would be that there are 900,000 acres of paddy land in Ceylon and that we are making an effort to bring in fresh land under cultivation. The impression that these 900,000 acres have no irrigation facilities at all is incorrect. There are three types of irrigation, major, minor and rain-fed. The fact remains that irrigation facilities are available for a substantial portion of these 900,000 acres. My friend Mr. Arumugam will support me that their policy would be not only for providing irrigation facilities for new land but also giving improved facilities for existing land. Out of the money spent annually, roughly 40 to 50 per cent. goes for providing effective irrigation facilities for old land. That is the point many speakers have missed.

The question was raised about intensified methods of cultivation. When the average of old land is about 900,000 and Government is bringing about 20,000 acres of new land per year under cultivation, we do not want a Colombo Plan expert to tell us that the answer for self-sufficiency lies in increasing the yield of the 900,000 acres of old land. The question whether we have to bring fresh land under cultivation is purely a matter of Government policy. I do not think that it is right for us to discuss. However if the members so desire, the Central Board of Agriculture can express its views.

Mr. Naranpanawa brought up this question of an administrative set up. What has this Rehabilitation Board got to do with the administrative machinery? Just having a Board will not answer the problem because whatever information is available must go down to the people. Judging from our staff, the extension staff in Ceylon is the highest in South-East Asia and if we are still unable to get through to every farmer I do not think a small Board sitting at Colombo or at Peradeniya will get right up to the village farmer. I think what is really needed is a Board that will give us advice say, in the same way as the Central Board of Agriculture to the Ministry and the Ministry can pass it down to the Departments concerned to get the work done. For instance this very Board raised the question of 'pathahas' and we have provided funds for all the areas of the wet zone for the improvement of 'pathahas'. But there are practical problems, for instance, when an old 'pathaha' has to be cleared the question of acquiring that land arises. Those are some of the practical problems. In the Kurunegala District the function of opening up 'pathahas' is not so easy but however we have done a good deal recently in this direction through the good offices of the Irrigation Department. We have about 100,000 acres in the west zone, in Colombo, Kandy, Galle, Matara, etc. We have a pilot project which has been established and we are trying out experiments. A plot of 100 acres has been set out. Twenty-five acres will be ready for cultivation this Maha season. It is really ideas like these that we want from this Board for the Government to work on. A productive report may be useful but what we want is something tangible for us to work on.

Now for instance, it is quite easy to say that land tenure is a problem that affects the present paddy cultivation but how should we face this problem? In Japan, you yourselves must be aware, that it

has been accepted that the farmer is the person who tills the soil and therefore he should be the owner of the land. The money is found to pay the landlord and the Government gives the money and in 25 years he repays the Government. Now 90 per cent. of the land has gone back to the tillers of the soil. Those are some of the suggestions or problems for a Board or a Sub-Committee which may be useful and on which the Government or the Ministry could act.

Another problem is crop insurance. I think that is a thing that should help the cultivator in greater production of paddy. Mention has been made tha not much progress has been made in the way o minor irrigation works. We actually come across problems of which we are making a study, and where necessary, the amount of money spent and the technical staff has been increased year by year. In this connection I would state that within a year or two restoration of 'pathahas' has been done and what can be done is being done. We are now spending about Rs. 3 million on minor irrigation and in areas where the District Agricultural Committees are active, more work than can be handled is being carried on.

I would like to mention before I conclude just a word about what has been achieved although we get no rewards. I have obtained certain figures from the Permanent Secretary to the Minister which would give an idea of our rice production for the last few years. In 1938 our imports of rice were 150,000 tons. In 1952 we have imported twice as much—300,000 tons. In 1954 we imported 450,000 tons. The import figures would roughly give us an idea of our progress when compared with previous years. The import figures would give a better idea of the position than any others as they may be incorrect or basically wrong. If we can produce 800,000 tons of rice, then we are perfectly justified in saying we could be self sufficient. If we can get anything over 60 bushels per acre we do not want to import rice. I do not think it is hardly necessary to mention, but it will be very helpful to the officers working in the Ministry of Agriculture and Food as well as those of the Home Ministry if members of the Central Board of Agriculture would give practical proposals that could be implemented by Government in the greater production of paddy in this country."

Dr. M. F. Chandraratne, Assistant Director of Agriculture (Technical)—"This report has been very considerably misunderstood. I should like at the outset to state that we have more or less 900,000 acres of asweddumized land of which 600,000 acres are cultivated in the Maha and 350,000 acres in the Yala, working up to a total of 950,000 acres of available acreage. Our imports of rice amount to 450,000 tons. To achieve self sufficiency we need an average yield of 67 bushels per acre. Now our yield per acre in Ceylon is about 30 bushels and accordingly, to achieve self sufficiency we must raise our yield by 37 bushels per acre. It is incorrect to say that our yields are among the lowest in the world. As a matter of fact, there is no country in South-East Asia whose yields are strikingly higher than ours. The only country in Asia whose yields are superior to ours is Japan. There has been an idea that the members of the Sub-Committee were insufficiently appreciative of the needs for intensification and were only thinking of extension of acreage. It is true that the core of this report is water consumption. That emphasis has been placed because we have been appreciative of the fact that no intensification is possible unless we have complete control of irrigation.

We are all familiar with the fact that a very considerable measure of weed-control is not possible unless the cultivator has a proper control of the water supply. It has become evident in recent years that not only is water necessary for weed control but that water is of tremendous importance in determining the development of the rice plant. For instance it has been pointed out in this report that water is regulated at certain stages of the growth of the crop for the purpose of stimulating root development. Unless you have a control over your water you might produce plants that would not sufficiently benefit by your fertilizers.

There are certain characteristic features in the Japanese methods. It is true that most of these features are merely intensification of methods normally practised by practically every paddy cultivator. Two essential features are complete control of weeds and the use of heavy dressings of fertilizers. Row-planting is about the only method by which we can assure inter-cultivation and complete weed suppression in a standing crop. With regard to the use of fertilizers, it is quite true that we in this country have varieties which as a result of generations of conscious and unconscious selections have developed a very low degree of fertilizer response and accordingly very heavy dressings of fertilizers would be wasted on our crops. Five years ago the practice of top dressing paddy with a nitrogenous fertilizer was completely unknown. If you travel through the North-Western Province today you will

find that 25 per cent. of the people who use fertilizers top dress their crops now with Sulphate of Ammonia. It is an indication of what this Department has done in the way of intensification of methods and it is also an indication of what features of the Japanese methods have been successfully incorporated into our planting practices.

Emphasis has been placed on remedying our system of tenure and our conditions of tenancy. It is true that the system has considerably contributed to our low cultivation standards. A tenant who is not sure of his tenure is not likely to incur expenditure in the way of permanent improvements to his field or to purchase expensive implements. I may say in this connection that in the first crop cutting survey that was carried out in 1949 I found a correlation between fields cultivated by the owners and those cultivated by the tenants. Owner cultivated fields had better yields than those of the tenants. That is an indication of one of the weak-spots in our cultivation."

Mr. G. B. Portsmouth—"The report has definitely placed its fingers on one of the major problems in reference to irrigation. We have been told that there are 900,000 acres under paddy cultivation. That is a very fine achievement. We have also been told that there is obviously very little control over the amount of water available to minor irrigation works, a point which is referred to in the report. I think the question of the control of water used by a cultivator is of the utmost importance if we are to increase the yields and the acreages that can be irrigated by any irrigation scheme. I do not know much about paddy cultivation but I have spent a number of years in one of the biggest irrigation schemes in Sudan. At the time I was there we had about one million acres under irrigation. The actual amount of water that went down to the fields was measured according to the acreages to be irrigated. Only enough water was let into each distributory canal to provide for the acreage to be irrigated and, if it was not drawn off by the cultivators when available, it was passed down into the next section of the canal for use in the next area. By that system the maximum use of the available water was made and the amount of water consumed per acre was very very low indeed. In more than half the area the work was done when there was no rainfall whatever. They entirely depended on the stored water. Unless we have sufficient control of our available water we cannot hope to improve our yields and our area under cultivation."

Mr. Clement Dias—"In our report we say that without water we cannot do very much. My experience is that I have 15 acres of paddy with a a small tank, which was started in 1932. When the villagers were cultivating it for me, they gave me only 200 bushels, but I am happy to say that I am now getting 750 bushels. I have invited the Chairman and the Minister to see those fields being harvested. I got these yields not by adopting any new methods or the methods adopted by the Agricultural Department. I am not blaming the Agricultural Department, but I qm mentioning my own experience. The Director of Food Production also went there and he was quite impressed with the cultivation. I would like to invite the members of this Board next time to see these fields. I have got from certain fields a yield of 135 bushels per acre. In Japan the highest yield has been about 300 bushels per acre with an average of 90 bushels per acre, but in Ceylon we cannot do so much. The Department has selected about 40 different varieties of seed paddy but most of them do not answer manuring. The Department has recommended to put in 2 cwt. of manure per acre. The villager puts in only about 56 lb. of manure per acre. I got these yields by putting in 300 lb. of manure. I can tell you that unless the people have the money to buy the manure and they have sufficient water for their cultivation, these Japanese and various methods of cultivation will never solve the problem. It is also important to see that the cultivator is educated in these various methods by practical demonstration. I am glad to say that Dr. Joachim has started a model plot of paddy at Kandawela for others to see and the P. M. himself is taking an interest. I feel that if our M. P's start similar schemes, they will do far better than talking".

Sir James P. Obeysekera—"I would like to know when actually the underground water table goes down in the Dry Zone".

Mr. S. Arumugam (representing the Director of Irrigation)—"Underground water table is not actually a subject that anybody has worked on so far. But an officer will very soon be sent out to spend about an year under one of those schemes and he will make a particular study of this subject. It is a most interesting subject and a very wide one too. Successful irrigation schemes will hold water on the surface. But all the irrigation schemes in Ceylon are said to be only for Maha cultivation and not for Yala cultivation or dry season cultivation. Some cultivators of course take the risk

and start their cultivation operations. The success of cultivation in the dry season depends on the underground water table which is dependent on the gradiation of the land cultivated. So that if our colonization schemes are to be a success our colonists should have a favourable gradiation. Underground water resources, especially in the N.C.P., is a very important subject to which attention will have to be given in the very near future. Otherwise the cultivators in these areas will have adverse results."

Dr. M. F. Chandraratne—" I would like to correct a wrong impression : this problem of underground water resources is very actively being worked out by Mr. Ernest Abeyratne and of course the results will be made available later ".

Gate Mudaliyar N. Wickremaratne—" According to the old irrigation system, water was issued from those village tanks which were along the channel. Even now there is evidence of these village tanks in the N. C. P. From Kalawewa to Anuradhapura a distance of 30 odd miles, you will see that every village has a village tank and the village tank is fed by the water of the larger tank. The system of drainage was such that tanks situated along the channel feed the smaller village tanks. Now what is happening is that these smaller village tanks have disappeared and the water table has also disappeared. It was an artificial water table, and in every village in the N. C. P. the water table was maintained in this manner."

Mr. N. H. Keerthiratne, M.P.—" With regard to paddy cultivation, we must, like in the case of tea, rubber and coconut, grow it only in places suitable for paddy. For instance you cannot grow tea in places which are only suitable for coconut. In the same way you cannot grow coconut in places which are only suitable for rubber. We must always see what is the most economic cultivation that is suited to the area. People in this country had the habit of growing paddy in any place where there was water without considering whether the area could be more economically utilised for any other crop. Now we have come to a stage where the labourer wants a suitable income. At a stage like this we must grow the most economic crop possible. We might think of growing onions or some other commodity for which there is a good market.

In regard to the question of insufficient irrigation water, I could suggest that the variety called "Elwee" is a drought-resistant paddy which may be encouraged. The Department should find out those varieties suitable for dry areas and those suited to wet areas and tell the people so that instead of their planting a variety which is suited to a wet area in the dry zone they could grow the variety which is most suitable. It is our job also to train the cultivators from our experience of different methods of cultivation. Rural Development Societies and A. G. AA. are at present doing that work but the work is going too slow. We must ask them to do it a little faster.

Then in regard to the system of pumping out water from marshy lands and converting them to paddy fields in the Kelaniya area, I think in the way they are getting about the job, they will never be successful, because there are no outer drains to take off the water that is pumped out.

About absentee landlords, although it is felt that the present state of poor paddy cultivation is due to absentee landlordism, I do not think that is really the problem now. When paddy was selling at 75 cents a bushel, the absentee landlord did not pay much attention to his fields but now paddy is fetching such a good price that the absentee landlord is there to collect his harvest. What we can do is to get the landlord to give the cultivator a better percentage of the harvest and instead of trying to nationalise all the paddy fields in this country and all the land, let the people come to some such arrangement. In a country where there is democracy we should not adopt totalitarian methods of forcing the people to do something. In places like Gal Oya and some of the major schemes where the owners themselves are cultivating, you cannot blame the absentee landlord, but still the standard of cultivation is the same. The secret of it is that our people are a bit lazy. The Jaffna man is quite different from the Sinhalese man. He has too much of difficulty to make a living. Our Sinhalese people are used to getting everything easily and they have become lazy.

In regard to the question of manure, I feel that it is time that this country establishes a fertilizer plant so that people will be able to obtain their manures cheaper for paddy cultivation ".

Mr. Albert Godamunne—" I quite agree with you. I have listened to all that has been said. I agree with almost everything but one thing I must disagree with. In recommending a Rehabitation Board we do not assign any blame to any Department of the Government. The Agricultural Department has so much to do in addition to paddy

The Director of Food Production has told us the amount of work they have done and the results they have got. The Director of Irrigation has shown us his difficulties and with these difficulties they have brought under cultivation 82,000 acres. How much did this 82,000 acres cost us ? How long did it take ? Now he says that under the Six Year Plan 20,000 acres will be brought under cultivation per year. When that is completed we will have 100,000 new acres on the one hand and 900,000 old acres on the other. In order to develop the 100,000 new acres, are we going to neglect the 900,000 old acres and leave it alone ? If that 900,000 acres can be improved and made to produce double or treble what it is now producing and at very much less expense we will be solving our problem. If the people could work these 900,000 acres and improve on its yields it will be an asset to our country. Our report was only in respect of the wet zone paddy. The Committee will devote its time for the next report on dry zone paddy. When the question of dry zone comes, we will have a lot of matter to submit to you and the Board. Today energy is being dissipated owing to the overlapping of one Department with another. Overburdened Departments are asked to tackle this. District Agricultural Committees are presided over by Government Agents who have to handle everything. Hardly any thinking and planning is done. It was said that in Japan the fields are of quarter-acre extents. Here it is sometimes less, sometimes more. It is really half an acre. We had laws and rules to regulate cultivation and the water supply. Today we have irrigation rules and there are supposed to be V.C. Rules in books. But in the major portion of the wet zone they are not being enforced. Practically non-existent. To enforce the rules some planning is necessary and some legal opinion has to be taken. That is why a Board is necessary to devote its entire time to this matter.

Mr. Keerthiratne commented about economy. Formerly a paddy unit was economical, but today it is not so. It cannot support a family. That problem has also to be tackled by some one and we recommend this Rehabilitation Board. That is to see to the rehabilitation of the paddy industry. Various other points were raised and all these point to the necessity of establishing a centralised Board that will devote its time entirely to this subject. The Director of Irrigation must be on the Board, the Director of Food Production and the Director or his representative should also be there. They will then direct and control the activities of the Board in addition to the planning. As I said time is the essence of this matter. This will help so many organizations responsible for this work to go ahead with it faster. Village Committees and others are doing their work. I am not blaming them. As an example I would like to say that I have a small acreage of paddy in the North-Western Province. For the last three years I am trying to get the District Agricultural Committee to put it into order but still it is in the paper stage. I have got a small area of paddy in Uva. Those paddy fields are worked once in two years. For the last twenty years I have been trying to remedy this. I have been trying to get a tank repaired. It was only half repaired, and still with all my efforts nothing has been done. Then in Kandy I have some fields which are transplanted when there is sufficient water. But when there is less water I cannot transplant. There is a 'pathaha' which has been sold to a company estate. We are trying to get it back and for this purpose I had to pester the Minister of Lands. To remedy all that I suggest in the wet zone, a Rehabilitation Board is necessary not merely to work up paddy fields or to see to irrigation but also to rehabilitate the industry as an industry and put the industry on its feet. Not merely to be a subsistence industry but to be a real economic industry as in the case of other industries. So I would like to say that all that was contributed here was a case for a Board to consider and plan out the execution of these proposals.

Mr. N. Manicka Idaikkadar, Director, Food Production—" After listening to all the speeches I feel that the opportunity should not be missed of commenting on the report submitted and in case Government has any difficulty in forming this Board, I suggest that the Paddy Advisory Committee meet at regular intervals and advise the Ministry of Agriculture and Food on the methods of rehabilitation from the existing administrative machinery. I might say for that reason, if after regular meetings this Committee has been able to do something useful to the country it may not be difficult for the Government to find a full-time Board ".

Chairman—" We have had a very interesting discussion on the Report of the Sub-Committee on Paddy, which Mr. Godamunne gave us a resumé of. The crux of the report is the creation of a Paddy Rehabilitation Board. Now the Director of Food Production is the one most concerned with the activities of this Sub-Committee, and he has suggested a resolution for consideration. The resolution

reads as follows :—" That the Paddy Sub-Committee consisting of the present members and Sir James Obeysekera, Mudaliyar Abul Cassim Marakar together with any other members it decides to co-opt, should meet at regular intervals to advise the Ministry of Agriculture and Food on methods of rehabilitation of the paddy industry throughout the Island by means of the existing administrative machinery ".

I would like to commend this suggestion very warmly. The Director of Food Production is a member of this Sub-Commiteee. At the last meeting it was decided that we should have two other gentlemen—Sir James P. Obeysekera and Mudaliyar Abul Cassim Marakar as well on this Committee. There is nothing to prevent the Sub-Committee co-opting others to it, if and when they think it desirable to do so. The Director of Irrigation or the Deputy Director of Animal Husbandry would be called in to give advice whenever necessary. I would therefore commend the proposal of the Director of Food Production for your consideration. If after experience, we find that more drastic measures are required, then I certainly think it would be within the powers of this Board to make a formal recommendation to the Minister that a Paddy Rehabilitation Board be created.

If you agree with my proposal, then I suggest that you adopt the resolution of the Director of Food Production.

The motion was carried unanimously.

V—Further discussion on the Resolution moved by Major E. C. de Fonseka at the 8th Meeting of the Board, on January 21, 1955

" That in view of the tremendous damage caused annually by fire to valuable patana lands and the destruction of springs and water supplies in upper Uva, immediate steps be taken by Government to prevent this by—

(*a*) planting up more forests,

(*b*) establishing fire lines, and

(*c*) requesting Headmen, Police and other Government departments to render assistance in preventing the spread of fires ".

Chairman—" In this connection I would like to say that there was a report by the District Agricultural Committee, Nuwara Eliya, on the subject. Recently too, Major Fonseka got in touch with me regarding the services of the Soil Conservation Officer on the subject of damage by patana fires. The Soil Conservation Officer visited the areas where the damage was greatest and, along with Mr. Fonseka, has drawn up a report which I think we might now consider. (The report was circulated among members).

Mr. T. Wickremasinghe, Soil Conservation Officer—" Last week Major Fonseka and I inspected the patana lands which are being burnt at the present time in Diyatalawa and discussed the problems of this practice pertaining to erosion in so far as it falls within the scope of the Soil Conservation Act, No. 25 of 1951. I therefore place before you the technical aspects of the problem in relation to soil erosion.

The annual firing of patanas is an important agricultural practice, because it is a very simple method of increasing the pasture in areas in which forage supplies are limited, and requires detailed study before any solution to tackle the problem might be attempted for the patanas are utilised by the village population in these areas to graze their cattle on, immediately after the cattle have ploughed the paddy tracts. It is, therefore, very valuable land as it caters to a very important aspect of all rural life, namely, cattle and should be tackled permanently.

Any attempt to solve the problem requires data of the cattle population in these areas which should be estimated on a Wasama or Village Headman's Division basis as it is the smallest administrative unit in Ceylon. The cattle population has to be classified into two groups for this purpose on the basis for which the cattle are maintained for some are required for draught purposes while others for milk, and the forage requirements for each are different. From this information it will be possible to determine the extent of grazing land required by the cattle population in each Wasama. Next the patana and other available areas for the purpose of grazing these cattle should be known on the same basis. If the grazing land is sufficient then there will be no problem of overgrazing but if the acreage of grazing ground is insufficient for the grazing of cattle within the Wasama, then there will be a continual problem of overgrazing and it will be necessary to provide extra grazing land. Since the

extent of patana land will be fixed, there will be no other way of increasing the quantity of grazing land unless some of the patana lands are improved by planting them in introduced species of grasses which will provide more forage for the cattle than the original ones. For this purpose it will be necessary that the patana land be surveyed and classified into units which will grow the introduced type of pasture without causing any adverse effects to the land as is being done at Harasbedde in the Nuwara Eliya District and Palugama in the Badulla District. Detailed information on the project to be forwarded to the public is not available at the present time since the project was started only a few months back. It is my duty to inform you that this matter is receiving the attention of Soil Conservation Staff in the Kotmale Revenue Division of Nuwara Eliya District where Soil Conservation staff are collecting information of the cattle population and available patana land. Due to lack of this basic information legislation under the Soil Conservation Act is not recommended which is also the suggestion in the report submitted by the District Agricultural Committee, Nuwara Eliya.

In the alternative we wish to support some of the recommendations made in the report of the Nuwara Eliya District Agricultural Committee to tackle the problem of patana burning in Ceylon. First is the problem of re-afforestation. A very large percentage of the land in patana at present, belongs to the Crown. According to the laws of this country, the utilising of this land for any purpose is vested with the Land Commissioner and the Government Agents in the district in terms of the Land Development Ordinance, No. 19 of 1935. According to this Ordinance, these lands have been reserved for village expansion schemes which aim at providing homes for the landless population in these areas. It is noticed from the land already given out under these schemes that no provision has been made for providing an adequate supply of fuel for the newly developed villages which is a basic need of the community. The problem of fuel becomes more difficult in areas in which the only vegetation is patana, for forests are several miles away and the cost of transporting firewood to them is exorbitantly high and consequently the villagers find it extremely difficult to obtain their daily requirements of fuel at a reasonable price. It is, therefore, suggested in the interests of the development of village expansion schemes in these areas, that approximately 25 per cent. of patana land be reserved for village forests to provide the fuel needs of the expanding villages in the years to come. However, this principle of providing village forests for these schemes has to be approved by the Land Commissioner and the Government Agents in the districts. It will be only when this has been accepted that the area can be inspected by a Forester and a Conservationist to demarcate the areas to be sited in forests. The Forester and the Conservationist will help to locate such of the forests that will act as protection to the homes, as well as the soil, from wind. It is hoped to plant out the forests in alternate bands with the patana grasses in between to achieve this purpose which will also act as an artificial check to patana fires.

Secondly we wish to recommend the formation of Patana Firefighting Organizations in these areas. Since these lands belong to the Crown and are under the care of the Revenue Officers in each district, it is suggested that the Revenue Officers issue instructions to the Rural Development Societies, Village Committees and other societies in the area to sponsor the formation of voluntary Firefighting Organizations to prevent the spread of patana fires. The sole purpose of these organizations will be to extinguish patana fires as soon as they are detected. The technical officers of the Department of Agriculture, Forestry, Wild Life, &c., should be co-opted to the Organization too.

Finally, we strongly recommend the propaganda measures recommended in the report of the Nuwara Eliya District Agricultural Committee which are—

1. To request the Education Department to include in their curriculum a lesson on nature study, animal husbandry and farm management in order to instil in the younger generation a love for the natural vegetation surrounding them.

2. The addressing of Rural Development Societies, Village Committees and Young Farmers' Clubs by technical officers to explain the disadvantages of patana burning.

3. The publication of a paragraph emphasising the prevention of wilful firing of patanas in the book entitled "Instructions to Headmen".

4. Requesting the Government Information Department to produce a documentary film illustrating the evils of patana firing and overgrazing.

5. To request the Government Information Department to conduct a poster competition for selecting the most attractive poster showing the adverse effects on the community by the continued practice of burning patanas.

I thank you gentlemen ".

Mr. Kenneth Morford commented on the damage that could result from patana fires and suggested the feasibility of introducing good posters to educate the people on the evils of this practise. He said he had seen some very good posters in England and some extremely good films on this subject. He added that he had seen some extremely good posters produced by the Forest Department three years ago at the Colombo Plan Exhibition. He also suggested that propaganda on this subject should be carried out in Schools and Rural Development Societies on a large scale as the Soil Conservation Officer had proposed.

Major E. C. de Fonseka—" With your permission I would like to read an extract from a letter I have received from Mr. A. B. Lushington, a former Conservator of Forests—' In the year 1935—exactly 20 years ago—I, as Acting Conservator of Forests, had a lengthy discussion with the late Hon. D. S. Senanayake on this very subject. There was nobody in Ceylon more alive to the disastrous results of this annual firing of patana lands than the Hon. D. S. Senanayake, and it was he who proposed that not less then 25 per cent. of the existing patanas should be planted with strips of forest trees as wind and fire breaks. He did not agree with the theory that the burning was a necessary evil, nor did he agree that the cultivator was unaware of the disastrous results of this indiscriminate burning, in fact he suggested that the planting of these strips would improve the grazing and ' help to protect the villager against himself '. Under the circumstances I consider that propaganda will merely result in a waste of time and money. For heaven's sake let the Forest Department get on with the main job of planting up these strips of forest which, in due course will help to control the burning and improve the intermediate grazing '. Gentlemen, my original resolution, you would see, is slightly different to the ultimate report produced by us. We are trying to tackle the problem from a different angle and ultimately our objective would be achieved. The Soil Conservation Officer has told us of the importance of having village forests. Especially in our part of the country, that is in the patana area of Upper Uva around Diyatalawa, the villager finds it very very difficult to get his fuel. In addition to his fuel he has great difficulty in getting posts for his fences and the timber to build his house. Therefore, one of the most important matters for the village expansion scheme is to establish village forests. In the process of establishing these village forests, as the Soil Conservation Officer pointed out, a certain portion should remain under patanas so that those patanas could later be turned into good grazing ground by introducing improved grasses. At the present moment I belive about 5 acres of this present patanas would be required to feed one animal. With improved methods the grass we grow should be sufficient for five animals. Then we would have solved the problem of cattle and we know what to do with then. So that really two problems have been tackled, the problem of firewood for the villager and also the problem of providing pasture for his cattle. Then again this question of soil erosion will automatically be tackled. Gentlemen, I feel that if this report is sent to the proper authorities, Mr. Wickremasinghe will be able to tell us what the Standing Committee on Land Development is doing in this matter. I think much time will be saved if the report is sent to them and they go into this matter at once ".

Dr. H. E. Young at this stage cautioned the members that the present practice of growing Eucalyptus was dangerous because if a spark were to get in, a fire could spread very rapidly.

Chairman—" Is there anybody from the Forest Department who could advise us on this point ? If not, I shall take the matter up with that Department ".

Major E. C. de Fonseka—" I wish to tell the previous speaker that Eucalyptus will not do that type of thing today ".

Mr. Ashmore Peiris—" Once these pasture grounds are established who will maintain them and on what basis would they be established ? "

Chairman—" For this purpose the Forest Department in collaboration with the Agricultural Department has started a series of trials in the Welimada area to determine how best pastures could be established on the patanas, the number of animals they could carry, &c. I can assure Mr. Peiris that it is the intention that these pastures be rotationally grazed. The trouble with communal pasture grounds is that everybody will want to benefit by them but nobody will look after them.

Mr. G. B. Portsmouth—" We have carried out some experiments with mana and other grasses. There is the possibility of developing grazing pasture purely by manure applications ".

Chairman—" I think the Soil Conservation Officer brought up two proposals—(1) to request the Standing Committee of Land Development to re-map the patana lands in Maha-Palata District for Village Expansion and allocate twenty-five per cent. of it for village forests, before the area is given out to the landless. The area to be planned as village forests to be re-surveyed with the assistance of a Soil Conservationist and a Forester and handed over to the Forest Department to be planted in trees for the use of the local population as fuel. This will be done. (2) to request the Minister to enlist the co-operation of the other Ministries and issue instructions to officers in various departments of these Ministries to form the nucleus of a voluntary organisation known as a 'Patana Fire Fighting Organisation'. This too will be done.

As far as the other matters are concerned, the Forest Department is taking steps to plant up more forests and they are also, as I stated, working in collaboration with the Agricultural Department to determine the type of pasture which could be established on those patanas, how best they could be maintained and what their carrying capacity would be. In the circumstances we shall await their report and findings which would be submitted to the Board from time to time.

We might now proceed to the next series of resolutions in the name of Gate-Mudaliyar Wickremaratne. If Gate-Mudaliyar Wickremaratne permits me, I would suggest, as the hour is a bit late, that we postpone his resolutions. If he chooses, I will be quite happy to place those resolutions first on the agenda of the next meeting of the Board ".

Gate-Mudaliyar N. Wickremaratne—" Sir, if there is no time to take up all the resolutions, may I suggest that at least the last one be taken up now ? ".

The Chairman agreed to this.

Mr. N. H. Keerthiratne—" Does it mean, he has given up the others, Sir ? " (Laughter).

VI—Resolution moved by Gate Mudaliyar N. Wickremaratne

" That the soil erosion from the tea and rubber estates and the silting of rivers and streams is coming to a real danger for future development of lands in the dry zones and this Board calls the immediate attention of the authorities concerned to take very serious notice of this situation and cause immediate steps to be taken to prevent soil erosion and if necessary to create a separate Department for this important work ".

Gate Mudaliyar N. Wickremaratne—" Ladies and Gentlemen—the present Soil Conservation Officer and his Department is what is remaining as a result of the efforts of a former Director. He took up the question of soil erosion as far back as 1921 and continued to work on it with a number of officers. I hope the members will appreciate the Soil Conservation Officer's report on patanas. Soil erosion is a very big problem in this country. Therefore, Sir, if this soil erosion is allowed to continue by the clearing of forests not only in the North-Central Province, but also in places like Tamankaduwa and Gampaha in the Magam Pattu, these rivers will carry down all the top soil that is washed away and the whole area will get eroded. Therefore, clearing of these forests I consider a waste of money as the frequent floods that these areas are subject to will erode the land. The first point is to stop soil erosion and then to adopt methods whereby a solution could be found for this problem. Attempts to conserve the soil have been going on from 1921. Now there is a proposal to re-plant tea estates and also to re-plant rubber. I visited a number of estates which are being replanted and I did not see any proper steps taken to prevent soil erosion. In the same way tea estates are also replanted without sufficient measures being taken for the prevention of soil erosion. There is one solitary officer, who has submitted this report, and who is engaged on soil conservation measures and I suggest that he should be given sufficient assistance to strengthen his branch ".

Chairman—" I wish to tell the Mudaliyar that we have a Soil Conservation Division of the Department. True enough it is at present not as large as we should like it to be. But it is a Division which is growing in importance and I am sure that the points you brought up will be duly gone into by the Soil Conservation Officer and his staff. According to the Ordinance there are what are known as

erodible areas. There is at present one such area which covers a major part of the tea area of this Island. The Soil Conservation Officer and his staff concentrate their work in that area in the first instance. Naturally, they do not want to enforce legislation because they want to do their work with the goodwill and co-operation of the people which are so necessary to effect successful soil conservation measures. The Soil Conservation Officer has set about his task in a very satisfactory manner by getting the co-operation of all the communities—the planting community, the village community and the others—by determining in common agreement with them how these measures could best be adopted. Therefore I think, we are going about this task slowly but surely. I am sure that Mudaliyar Wickremaratne will agree with me when I say that soil conservation is not neglected. We have borne it in mind from the days of Sir Frank Stockdale. A Committee reported on the subject in the year 1930, and its recommendations have been adopted in many ways, especially in the tea and rubber districts. Those who are concerned with these industries are themselves most anxious to see that soil conservation measures are adopted on their properties for in doing so they are safeguarding their own interests as well as that of the country. I think I should say that on most progressive estates the soil conservation measures are quite satisfactory, and that they co-operate fully with the officers of our Soil Conservation Division in this matter ".

Gate Mudaliyar N. Wickremaratne—" Have planters adopted any scheme under which 500 acres would be brought under soil conservation ? Have they thought of it and made any arrangements to bring under soil conservation an estate of say, 500 acres or over, and how long will they take to do it ? "

Mr. Kenneth Morford—" I would like to reply to that. The Soil Conservation Department have been conducting classes for planters which have been well attended. Estates, or a hill side, is taken as a whole and not piecemeal. We carry out major soil conservation measures according to the degree of possible erosion. Regarding villages in the Kotmale area, officers of the Soil Conservation Department have been working for some time, and are doing excellent work.

I am sure that the problem of Soil Conservation is now understood by all, and the live policy of the Soil Conservation Department is obtaining the support of all—planter and peasant—and erosion from cultivated areas will soon be checked.

Mr. Albert Godamunne—" Isn't there and Ordinance that there should be at least 40 chains left on either side of streams uncleared when areas are planted up ? "

Mr. T. Wickremasinghe—" It is not 40 chains but two or three chains the maximum for forest reservations. I am sorry that it has not been enforced, not by planters and villagers but by the Government itself. It is not possible to do anything now about those reservations because some of them have already been alienated to villagers. We are trying to get that enforced. When I raised that point with the Chairman of the Soil Conservation Committee of the Board, he said he was taking steps to see that it is implemented ".

Chairman—" Would you leave it to us to see that this matter is not lost sight of ? "

Gate Mudaliyar N. Wickremaratne—" Sir, if you undertake to represent matters to Government to strengthen that Branch, I will be satisfied ".

Chairman—" Representations have been made by the Nuwara Eliya District Agricultural Committee that another area be declared erodible. Mr. Wickremasinghe has submitted a report on that matter to Government and when this is approved, the necessary staff will be provided for ".

Mr. N. H. Keerthiratne, M. P.—" What Mudaliyar is worried about is that soil conservation measures should be adopted on whatever areas are replanted "

Mr. M. Atkinson—" The drains we cut are 'lock and spill' drains, not drains to get the water away from the land. There is nothing more we can do."

Mr. T. Wickremasinghe, Soil Conservation Officer—" During the last two years I have been working in the planting districts and I have received full co-operation from the Chairman of the Tea Research Institute and from Mr. Kenneth Morford, when he was last P. A. Chairman. I had the fullest co-operation from him and I am getting the same co-operation from the present Chairmen. I think the Rubber Research Institute themselves are actively engaged in tackling the problem of soil erosion.

Dr. H. E. Young—" One of the conditions for the grant of the subsidy is that soil conservation work such as digging trenches, silt pits and planting cover crops have to be done before the subsidy is given. In regard to new planting, your own Department gives the soil conservation grant which a Small Holdings Officer will not pay to the village small holder unless he carries out these measures ".

Mr. G. B. Portsmouth—" As far as the Tea Research Institute is concerned we are actively co-operating with the Soil Conservation Department, and a number of Tea Instructors and Small Holdings Officers are actively engaged in developing soil conservation methods in co-operation with the Soil Conservation Officer of the Department, and they pass this information to the rest of the people concerned.

Chairman—" Gentlemen, we are reserving the rest of Mudaliyar's resolutions for the next meeting ".

The meeting terminated at 5.45 p.m.

N. P. WIJEYERATNE,
Secretary,
Central Board of Agriculture.

Peradeniya, October 11, 1955.

ANIMAL DISEASES RETURN

April-June, 1955

Province	Disease	Fresh Cases during the Quarter	Total Number from the beginning of this Calendar year to Quarter ending June 30, 1955				Balance ill at end of the Quarter
			Cases	Deaths	Shot	Recoveries	
Western Province (excluding Colombo Municipal area)	Foot-and-mouth	6	54	—	—	54	—
	Rabies	58	139	—	139	—	—
	Piroplasmosis	23	23	17	—	5	1
Northern Province	Anthrax	4	64	64	—	—	—
	Rabies	—	1	—	1	—	—
North-Central Province	Black Quarter	—	38	38	—	—	—
	Rabies	1	3	—	3	—	—
	Haemorrhagic Septicaemia	688	740	727	—	13	—
North-Western Province	Foot-and-mouth	339	1,698	246	—	1,446	6
	Rabies	4	8	—	8	—	—
	Surra	1	1	1	—	—	—
	Sarcoptid Mange	40	40	—	—	40	—
	Piroplasmosis	7	7	6	—	1	—
Central Province	Foot-and-mouth	—	72	—	—	72	—
	Piroplasmosis	—	2	1	—	1	—
	Rabies	11	19	—	19	—	—
	Mange	1	1	—	—	—	1
Province of Sabaragamuwa ..	Rabies	4	13	—	13	—	—
Province of Uva	Foot-and-mouth	67	125	9	—	90	26
	Rabies	2	9	—	9	—	—
Eastern Province	Foot-and-mouth	—	172	—	—	172	—
	Rabies	1	1	—	1	—	—
Southern Province	Foot-and-mouth	1,690	5,422	520	—	4,084	818
	Rabies	6	9	—	9	—	—

T. M. Z. MAHAMOOTH,
Deputy Director (Animal Husbandry) and Government Veterinary Surgeon.

Department of Agriculture,
Peradeniya, Ceylon,
September 13, 1955.

METEOROLOGICAL REPORT

July to September, 1955

Station	July									August			
	Temperature				Humidity		Rainfall			Temperature			
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night from Minimum	Total	Offset	Number of	Mean Maximum	Offset	Mean Minimum	Offset
Anuradhapura ..	90·2	—0·7	74·8	—1·1	63	88	1·84	0·52	2	89·4	—2·1	74·3	—1·3
Badulla	85·2	—1·0	64·3	0·1	67	94	5·13	2·96	9	85·0	—1·0	64·0	—0·5
Batticaloa	89·7	—2·3	76·5	—0·5	67	82	2·93	1·89	4	88·2	—1·8	75·7	—0·8
Colombo	84·2	—0·5	76·3	—0·5	76	84	3·68	—1·81	14	85·3	0·4	76·9	—0·1
Diyatalawa	78·6	0·7	60·2	—2·4	65	86	1·73	—0·23	10	78·7	0·8	60·2	—1·5
Galle	82·1	—0·6	76·7	0·1	83	86	8·47	2·13	21	82·7	0·1	77·8	—1·1
Hambantota	85·4	—1·9	76·2	—0·1	79	88	0·57	—1·44	4	88·0	1·0	76·8	0·7
Jaffna	85·7	—0·4	79·3	—0·5	78	85	0·99	0·44	2	86·2	0·1	78·9	0·4
Kandy	80·8	0·7	68·7	—1·1	71	87	3·89	—2·00	20	82·1	0·6	68·4	—1·5
Kankesanturai ..	89·9	—	78·6	—	68	86	1·35	0·81	3	87·9	—	77·7	—
Kurunegala	86·3	0	75·1	—0·1	73	88	1·39	—2·49	11	88·5	1·7	75·4	0·5
Mannar	86·7	—0·7	78·8	—0·3	74	82	0	—0·35	0	87·7	0·3	78·3	—0·3
Nuwara Eliya ..	66·1	0·9	53·8	—1·1	81	88	4·74	—6·28	21	67·4	1·3	54·6	—0·2
Puttalam	87·3	1·3	78·1	—0·1	69	82	0	—0·99	0	88·5	2·1	77·6	—0·4
Ratmalana	85·2	—	77·2	—	71	80	6·08	0·62	17	86·2	—	78·2	—
Ratnapura	86·5	—0·1	73·9	—0·5	75	90	14·01	1·24	22	88·4	1·7	74·3	0
Talawakele	68·8	—1·4	58·3	—1·2	84	91	9·37	—3·93	23	70·8	0·3	58·4	—0·8
Trincomalee ..	92·5	0·1	77·9	—0·1	59	78	2·02	0·29	4	90·2	—2·0	76·4	—0·9

Station	August (contd.)					September							
	Humidity		Rainfall			Temperature				Humidity		Rainfall	
	Day	Night (from Min. Temp.)	Total	Offset	Number of Days	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Min. Temp.)	Total	Offset	No. of Days
Anuradhapura ..	70	93	5·76	4·14	9	89·7	—2·1	73·5	—1·6	71	95	7·35	3·59	13
Badulla ..	66	94	6·41	3·21	7	83·9	—1·8	64·8	0·6	73	94	7·02	3·53	17
Batticaloa ..	71	84	7·07	5·12	7	86·2	—3·6	75·9	—0·3	75	86	1·37	— 1·02	4
Colombo ..	74	84	1·11	—2·92	10	85·2	—0·2	73·9	—2·7	79	90	15·84	9·00	24
Diyatalawa ..	65	83	5·75	2·63	11	76·8	—1·0	60·5	0·4	75	89	9·89	5·48	18
Galle ..	81	93	1·74	—4·40	14	83·7	0·7	76·4	—0·3	82	86	13·23	4·42	—
Hambantota ..	74	86	0·42	—1·02	4	85·4	—1·2	75·8	—0·4	80	91	0·85	— 1·91	10
Jaffna ..	78	80	1·48	0·37	6	86·5	0·3	79·9	0·6	78	82	2·00	— 0·53	7
Kandy ..	68	87	2·75	—1·99	12	83·6	1·4	67·5	0·1	71	90	10·37	4·39	23
Kankesanturai ..	71	89	4·00	2·74	7	89·1	—	78·6	—	74	89	0·75	— 2·22	11
Kurunegala ..	68	86	2·85	—0·77	7	88·1	0·5	73·3	—1·1	73	93	13·61	8·06	23
Mannar ..	77	89	0·54	—0·12	2	88·0	0·3	78·6	—0·2	78	89	2·73	1·49	8
Nuwara Eliya ..	78	85	3·68	—3·83	13	68·6	1·8	53·0	—0·2	81	88	10·64	2·40	21
Puttalam ..	68	84	0·19	—0·46	5	88·4	1·5	76·6	—1·3	71	86	3·80	2·22	15
Ratmalana ..	68	78	0·92	—2·56	10	86·1	—	74·5	—	74	88	16·73	9·89	25
Ratnapura ..	71	90	3·15	—8·24	20	88·2	1·0	73·0	—0·5	76	93	21·56	7·04	24
Talawakele ..	82	91	3·65	—6·43	16	71·7	—	56·5	—	88	97	10·68	0·93	22
Trincomalee ..	67	82	4·92	1·31	16	90·2	—1·9	76·6	—0·5	68	84	3·11	— 0·50	5

SUMMARY

ORDINARY south-west monsoon prevailed over the Island during July. Winds were generally moderate south-westerly, while rainfall was mainly confined to the south-west quarter. This rain was moderately heavy in the south-western foot-hills and neighbourhood on the 18th, a number of stations recording falls exceeding 3 inches. Owing to weak monsoon conditions evening thundershowers were experienced, in the north on the 24th, and on the east side on the 3rd, 25th and 28th. The rainfall on the 28th was fairly widespread. The weather was dry over the whole Island on the 4th and 5th. Greatest monthly totals occurred in the south-western foot-hills and neighbourhood, where the aggregates at several stations exceeded 20 inches. From this region there was a gradual decrease in rainfall towards the coast, monthly totals at the south-western coastal stations being of the order of 5 inches. Outside the south-west quarter the rainfall was below 2 inches, except in Batticaloa District and the neighbourhood of Badulla, where it ranged from 2 to 5 inches. Over 80 stations in the north-central and north-western parts and in the neighbourhood of Hambantota received no rain at all. The rainfall was above normal in the south-western mid-country, in Batticaloa District and in the neighbourhood of Badulla, it was generally below normal elsewhere over the Island, the bigger deficits (those exceeding 5 inches), occurring in the south-western hill-country.

Although south-west monsoon weather prevailed over the Island during August, the winds were mainly dry Consequently, the rainfall in the south-western parts was well below normal, deficits in the hill-country generally exceeding 10 inches. These shortfalls were not so much due to lack of rain-days, as to he actual daily falls being light. On the other hand, the eastern and north-eastern parts of the Island recorded an appreciable excess of rain. There were two contributory causes to this. First, owing to weak monsoon conditions during the period, 4th to 9th, evening thundershowers were experienced frequently in this region, with moderate falls occasionally, while on the 14th and 15th, widespread rain occurred over the whole Island, due to a low pressure wave in the Bay of Bengal. The bigger excesses (which were of the order of 5 inches) were found among the Uva Hills. The bigger monthly totals of rainfall ranged generally from 5 to 10 inches only, and occured in the south-western hill-country and in Uva and North-Central Provinces. The rainfall was below 2 inches in the western and north-western low-country, in Jaffna Peninsula and in Hambantota District.

Low pressure waves and evening thunder activity itermingled to produce excessive rain in the south-western parts during September. Rainfall was experienced, more or less continuously, between the 11th and 28th, with moderately heavy amounts on several days. It was heaviest on the 22nd, when, on account of a low pressure wave, fairly widespread rain was experienced over the Island, with several falls over 5 inches in the south-western low and mid-country. Another low pressure wave caused similar rain on the 18th, but the rainfall was less intense, the heavier falls occurring along the south-west coast only. On the 25th and 26th, rain with occasional gusts of strong wind, was experienced, on account of a depression in the Bay of Bengal. During the early part of the month the weather was mostly dry, although south-west monsoon conditions prevailed. The rainfall was heaviest in the south-western low and mid-country, where the monthly totals ranged between 15 and 25 inches, the highest being 35·05 inches at Weweltalawa Estate (Yatiyantota), and 32·95 inches at Blackwater Estate (Nawalapitiya). In the North-Western and North-Central Provinces the rainfall occurred in the Jaffna Peninsula and in Batticaloa and Hambantota Districts. Rainfall was above normal over a major part of the Island, the greater excesses (of the order of 5 to 10 inches or more) occurring in the western low and mid-country, among the Uva Hills and in Kurunegala District. Deficits (generally small), occurred in the Southern Province, Batticaloa District, Jaffna Peninsula and in the south-western hill-country. A hailstorm was reported from Peradeniya on the 16th.

D. T. E. DASSANAYAKE,
Director.

Department of Meteorology,
Bullers Road, Colombo 7, October 14, 1955.

ORDINANCES

[Extract from the "Ceylon Government Gazette" No. 10,828 of August 19, 1955.]

L. D.—B. 6/29.

THE PLANT PROTECTION ORDINANCE

Regulation made by the Minister of Agriculture and Food by virtue of the Powers vested in him by section 9 (3) (g) of the Plant Protection Ordinance (Chapter 307), as modified by the Proclamation published in *Gazette Extraordinary* No. 9,773 of September 24, 1947.

J. R. JAYEWARDENE,
Minister of Agriculture and Food.

Colombo, August 10, 1955.

Regulation

No person shall, for the purpose of the preservation or packing of fish intended for transport, use the plant or any part of the plant known as Salvinia auriculata or water fern, which has been declared to be a weed by notification published in *Gazette* No. 10,447 of September 12, 1952.

[Extract from the "Ceylon Government Gazette" No. 10,828 of August 19, 1955.]

L. D.—B. 6/29.

THE PLANT PROTECTION ORDINANCE

Notification

By virtue of the powers vested in me by regulation 5 of Part II of the regulations set out in the Schedule to the Plant Protection Ordinance (Chapter 307), as modified by the Proclamation published in *Gazette Extraordinary* No. 9,773 of September 24, 1947, I, Junius Richard Jayewardene, Minister of Agriculture and Food, do by this notification, amend the notification made under the aforesaid regulation and published in *Gazette* No. 10,447 of September 12, 1952, by the substitution for the expression "Salvinia cucullata" of the expression "Salvinia auriculata".

J. R. JAYEWARDENE,
Minister of Agriculture and Food.

Colombo, August 10, 1955.

[Extract from the "Ceylon Government Gazette" No. 10,834 of September 2, 1955.]

CACAO SUBSIDY SCHEME

Reference the recent notification by the Rubber Controller in regard to applications for subsidies for the 1956 replanting of rubber lands.

Applications are invited for cacao interplanting subsidies from owners of rubber lands 1,200 feet and over in elevation in the Kandy, Matale, and Badulla districts which are considered suitable for interplanting with cacao.

These applications should be made on the prescribed form obtainable from the Cacao Rehabilitation Officer, Horticultural Office, Peradeniya, from whom all particulars regarding the Cacao Subsidy Scheme could be obtained.

Applications close on September 30, 1955.

A. W. R. JOACHIM,
Director of Agriculture.

Department of Agriculture,
Peradeniya, August 23, 1955.

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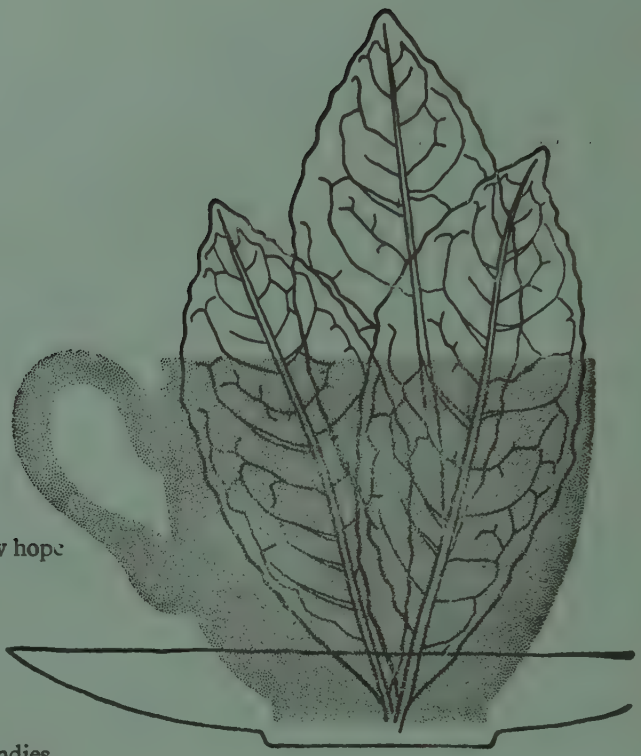

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TROPICAL AGRICULTURIST

Volume CXI October-December, 1955 Number 4

Published Quarterly By

DEPARTMENT OF AGRICULTURE
PERADENIYA, CEYLON

Subscription Rates

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Registered as a newspaper in Ceylon.

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(1) Manuscripts for publication should be typewritten on one side of the paper at double spacing and sent in duplicate to the *Editor, Tropical Agriculturist, Department of Agriculture, Peradeniya, Ceylon.*

(2) Articles should be divided into sections, each headed by a caption, and concluded with a brief summary, if necessary.

(3) Text figures and photographs must be (*a*) suitable for reproduction, (*b*) supplied with legends typed on separate sheets of paper, and (*c*) separate from the text but allocated to sections of the text.

(4) References should be numbered in the order quoted in text, and should contain names and initials of authors and title of book or paper.

(5) Titles of manuscripts should be brief.

EDITORIAL

Grassland Agriculture in Ceylon

UNLIKE THE COOLER regions of the world, the tropics are not framed for their grasslands on which livestock of high productivity is raised. Although there are several good breeds of cattle in India and Africa, most of these are reared on the natural grasslands of those countries and they do not bear comparison either in milking or beef quality with stock raised on well managed, established pastures in the temperate zone.

In Ceylon, the natural grasslands are too coarse to rear even good draught animals nor is the sward sufficiently close and compact to be of value in conserving soil and water and in improving the fertility of the land. The only indigenous breed of cattle that has developed is the Sinhala which is a small but hardy animal, poor whether for milk, beef or draught purposes. With the need for more milk production in the Island, both Government and the public have from time to time imported foreign breeding stock from the U. K., India and Australia. These animals are fed on certain introduced grasses that grow more vigorously than the local grasses and have proved successful for soiling. Popularly referred to under the general name of fodder grasses in this country, those that are commonly grown now are Guinea, Napier and Water which are planted in comparatively small plots, cut periodically and fed fresh to the animals which are for most part, kept in the farmsteads. On account of the inferior feeding value of these grasses as compared with forage of temperate countries, dairy animals, in particular, have to be given ample quantities of locally produced concentrates which fortunately are relatively cheap.

Several attempts were made in the past to introduce other grasses both for direct grazing as well as soiling, but until recently none of these proved to be superior either in yield or the quality of the herbage to the three grasses already mentioned.

In 1946, the problem of establishing good pastures that would provide better feed than soiling especially to the imported breeds of cattle was given more serious attention and trials with a number of indigenous and introduced grasses and legumes in several agricultural stations were undertaken. There was considerable promise of success with some of the species, but one of the introduced grasses, *Brachiaria brizantha* popularly called Signal grass introduced in 1951 from Queensland, though its original home is East Africa, soon gave evidence of being an outstanding success. It has proved to be remarkably vigorous and able to survive long spells of dry weather. Though it flowers well most of the seeds are not viable and propagation has to be carried out from cuttings but this is not a serious

difficulty for by throwing the cuttings into ploughed furrows which can then be closed by discing or harrowing the land large areas can be quickly planted up. A large quantity of cuttings has been issued mostly from the Livestock Farms of the Department where extensive fields of pastures under this grass have been successfully established and maintained. It is estimated that there are altogether about 10,000 acres now in Signal grass pasture under regular grazing.

There still remain several other aspects of pasture work to be investigated in Ceylon. Apart from developing suitable strains of Signal grass that will produce viable seed—though this is not a major problem at present—suitable legumes that will grow in close association with the grass have to be found. Signal grass develops such a vigorous habit that when fully established it dominates the sward and even weeds cannot survive the competition. The following legumes, however, are known to be persistent, drought resistant and deep rooted and of all leguminous species they are considered to be most likely to succeed as the components of Signal grass pasture: *Indigofera endecaphylla*, *Desmodium sandawicense* and *Centrosema pubescens*. Trials with these and even other species will however indicate whether legumes can be successfully established with Signal grass. In view of the fact that the cheapest supply of protein feed for livestock in the world is found in coconut cake of which there is a plentiful supply in Ceylon, the inclusion of legumes for the purpose of increasing the protein content of a pasture is not of great importance at the moment.

It is necessary for research to be undertaken on grazing intensities in the different zones of the Island, on the nutritive value of the pasture at different periods of the year, and under different systems of grazing, and on the contribution of the pasture to soil fertility.

The advantages of establishing pastures and of practising a system of grassland husbandry are perhaps not sufficiently known to many agriculturists of this country who for years have been accustomed to think in terms of soiling. Apart from the fact that under soiling, not more than about 60 lb. of fodder grasses can be consumed a day by an animal, in comparison with a consumption of over 100 lb. a day with direct grazing of pastures and also the higher nutritive value of the latter, the labour costs in soiling are a serious disadvantage in the system.

An established pasture forms a close sward which acts more efficiently in reducing the lateral movement of water and soil particles than row planted fodder grasses and hence is of value as a soil and water conservation measure. It is said that "grassland farming is conservation at its best." There is no better way of protecting the soil against wind and water erosion than by putting land down to pasture.

Another advantage of pasture lies in its contribution to soil fertility. Complete protection is afforded against exposure to the sun which causes a breakdown of organic matter in the soil in the tropics. The fibrous grass

roots improve the crumb structure and organic matter of the soil and when legumes are also present, the nitrogen content at low cost. The deep roots of the legumes will open up the sub-soil and utilize the minerals from the lower horizons. Investigations to assess the contribution of a Signal grass-legume pasture to soil fertility as compared to tree vegetation are in progress at the Research Station, Maha Illuppallama.

If a suitable pasture is found to be valuable not only for raising good livestock but also for improving soil fertility, then grassland agriculture must be the basis of an integrated system of crop and animal husbandry which must needs play a vital part in the Island's economy.

ARTICLES

The role of Grassland in Ceylon's Agriculture

A. V. ANKER-LADEFOGED

ALTHOUGH LIVESTOCK, and especially cattle and buffaloes, have been raised in Ceylon for many centuries this aspect of farming is yet poorly developed and it does not play an important role in the country's agricultural economy except from the point of view of providing animals for draught. Many reasons have been given for this state of affairs and out of those the main one is, no doubt, that foods of animal origin have not until recently been in great demand and markets, therefore, poor. Nowadays, however, animal protein in some form or other is regarded as an essential component of a good diet, so much so that the average level of its daily consumption is considered by nutritionists as the most useful index for the quality of human nutrition. Milk, meat and eggs are considered among the most important protective foods. Here, where the livestock industry is undeveloped, the production of foods of animal origin is far too low to meet the requirement and large quantities are imported. To meet this situation and provide for the upward curve in human population, expansion and improvement of the animal industry must take place and such development should be based on a sound grassland policy. It is for us to develop sound systems of farming that will cater for the demands while at the same time keeping the soil intact and fertile. To this whole concept grassland farming is of fundamental importance.

Integration of crop and stock husbandry represents a definite advance towards a more stable system of agriculture and a greater assurance of a permanent food supply of high quality and therefore, if it is accepted, that livestock do fulfil a useful, indeed a vital role in both our agriculture as well as for our dietary needs, we must find methods by which to increase the economy of livestock production. Grass is without doubt the cheapest food for herbivorous stock and the cheapest way of feeding it is for them to help themselves; more and better grassland should therefore be given a prominent place in Ceylon's agriculture and be increasingly relied upon to bear the burden of the present and future livestock population. In this connection one should not think only in terms of simple pastoral practices but of a high level of managerial conditions. If such a marriage between crop and animal husbandry can be realised the purpose fulfilled will be three fold, viz., it will serve as a medium for maintaining and increasing the fertility in the soil; it will ensure that those portions of the crop which are inedible to man are not going waste; it will help to bring about a more stable economy for the farmer. As things stand to-day this aspect of the country's agricultural practice is hundreds of years behind when compared to some of the highly developed monocultures.

In the past when discussing the environment of tropical cattle a great deal of emphasis was placed on the climate. Important though this factor may be, it should not completely overshadow the other environmental factors such as vegetation and management practices. Management is in fact the most variable of all factors concerned with livestock production. Throughout the world successful animal husbandry is best built on a foundation of grassland, but here this was never so. Even today the bulk of the food, if considered on a digestible dry-matter basis, consumed by that portion of the stock which can be taken as economic producers, consists of concentrated foodstuff and not, as it should be, of fodder or pasture. Price relationship between foodstuff and animal products is at present such that this type of feeding no doubt is economic, but livestock are more useful in agriculture if they are more closely integrated with crop production. Cattle and buffaloes, being ruminant animals, have the ability to consume large quantities of bulky foods (grass, straw and other roughage) and to convert them into meat, milk and fat. This asset must be exploited to the fullest possible extent in order that the concentrates fed in addition are used to the best advantage. The feeding of the cow is a subject which has undergone much research and investigation both in laboratory and in the field. The balancing of rations in respect of proteins, starch, minerals etc. and the careful blending of raw-material to give the maximum yield is now the rule in advanced livestock farms with no detrimental effect to the animal. In the tropics these problems need much more investigation and experimentation. It is still usual to find feeding standards solely based on experiments carried out under cooler conditions applied to the rationing of cows in the tropics, although it is obvious that these standards require considerable modification. In Ceylon, experience from experimental livestock farms has made us realize that a fundamental investigation into the merits of indoor and outdoor feeding and management is a necessity. One thing is, however, certain in regard to feeding of stock in Ceylon, namely that fodder and pastures must be relied upon much more as a basis for feeding stock than has been the case hitherto.

Considering that grassland is so important to the increased production of livestock products and for maintaining soil fertility, particularly in areas where arable crops are grown, what are then the practical steps which should be undertaken to develop and utilize efficiently this potential source for increased food production? This problem is obviously two fold, production on the one hand and utilization on the other.

Natural Grasslands

In regard to production the present position is easy to appraise as only a small acreage of improved grassland exists in the country, the great majority of stock being fed on natural pasture lands. Introduced pastures and fodder areas cover only a fraction of Ceylon's agricultural area, and improved management practices are confined to a few farms and holdings, many of them being Government farms. In this brief account only general mention can be made about Ceylon's natural grasslands, which cover large tracts and are of very varying types ranging from the *patanas* in the highland region to the finer and more

palatable species in the dry-zone forest. Organised use of the natural grassland does not exist on any scale worth mentioning. Those made use of are far apart and often over-grazed. One cannot but regret this state of affairs when remembering that grassland is rightly credited with being second only to good forest cover in effecting soil and water conservation. Misused grassland, on the other hand, is one of the most powerful agents for soil destruction. Ceylon is relatively thinly populated with cattle and buffaloes, but still such misuses of grassland are common. Natural grasslands should be a matter of public concern because it is one of nature's most effective means of protecting against drought and flood hazards.

Although the use of introduced pastures and fodders are likely to provide the key to progressive grassland farming, the natural grasslands will always be an important factor in stock husbandry and steps should be taken to preserve a balance between utilization and deterioration. It should not be forgotten that the use of introduced pastures presupposes a standard of farming which provides for suitable management, and that it will take a long time before a radical change from existing primitive methods of utilization to a high standard of grassland use can be common practice in rural districts.

The natural grasslands in the highland districts are generally lacking in good species. There are only few plants from these which could be considered worthwhile using in improved pastures. Most of the grasses, as well as the non-graminaceous plants, are unpalatable and low yielding.

In up-country areas there is a gap in nature as far as pasture production is concerned, viz., the acidity of the soil caused by heavy rainfall and as a consequence thereof, leaching at a rapid rate. This situation is often aggravated by indiscriminate burning during the dry seasons. Soil acidity in the highlands is a very limiting factor for pasture development on a large scale due to the high cost of liming the lands which have to be a regular feature if satisfactory production both in regard to quality and quantity is the ultimate aim. Results obtained on Government livestock farms clearly indicate that a satisfactory sward cannot be maintained on the *patana* lands above 4,000 feet unless liberal amounts of artificial manure and lime are supplied regularly. This does not mean that there is no scope for pasture on such lands; but far from being so, it means that a good standard of management is a necessity for successful grassland farming. However, the areas above 4,000 feet covered by these special conditions is small and the scope for cattle farming very limited. Pasture plants from temperate zones have been successfully established at elevations above 5,000 feet and they produce well provided the level of pasture management is satisfactory.

The greatest hope for improvement and expansion lies in the low-country districts, particularly in the drier parts. There it can be safely assumed that the soils are quite capable of development to a level of good grassland value. The natural flora indicates this clearly. Conditions are also very good in the wet low-lands, but here grasslands will usually be maintained in direct and serious competition with crops grown for direct human consumption or various cash crops. Here again, grassland development is faced with the general problem of the small size of farm

units. Rotational fodder crops or permanent fodder crops maintained under a high manurial level are probably the answer under such conditions. There is, however, one great exception, viz., the vast acreage covered with coconut plantations. The approximate one million acres covered by this important industry could make a tremendous contribution towards the country's supply of animal food if the natural pastures which cover the ground under the palms are either improved by systematical management and grazing or replaced by introduced pastures of more productive species. Such a development is generally considered desirable also from the point of view of increased coconut production.

The dry-zones offer in many ways excellent prospects for extensive grassland development. Although the present extent of natural grassland is confined to roadsides, round tanks, under forest, park-lands and on river banks, it possesses enormous potentialities for livestock production, but to do so its utilization will have to be organised. At present some areas are badly ruined by overgrazing while others are not used at all. The problem of its proper utilization will have to be tackled with vision and vigour, or else no fruitful result can be expected. Many peasants regard natural grazing grounds as "waste land" and no attempts are made to use them in any organised way. One fine example of natural potentialities is the excellent natural pastures found along the Mahaweli and its branch rivers in the Tamankaduwa district. It is doubtful whether better natural pastures exist in any other part of the world. This gift of nature is far from being fully utilized; if properly utilized it may well be the basis for a scheme of milk production large enough to cater for more than half the Island's requirements.

On the whole it can be said that most natural pastures are what they are because of the peasant and his animals

Natural Pasture—Tamankaduwa

whenever grazing ground is left to itself the organised sword is gradually replaced by miscellaneous scrub etc., and given sufficient time it will revert eventually to scrub or forestland. Exceptions are pastures along rivers where annual floods control the situation and the hill *patanas* subject to periodical fires. The system of having communal pasture lands, or so-called reserves, as grazing grounds for a large group of small holders should be discontinued, as it always results in bad management and subsequent destruction of the sward. Such reserves could normally be more profitably used if they were divided among individuals. A policy entailing heavy expenditure of public funds on the development of grazing reserves for common use could be jutified only in those cases where there is evidence that there will be sufficient co-operation within the community to assure future maintenance. On natural pastures, as well as on introduced ones, the management of the grazing plays a direct part in the productivity, vigour and botanical composition of the sward. In tropical regions there is a very strong argument in favour of promoting a vegetative cover as dense as is possible to achieve under prevailing conditions and this can only take place if grassland is used systematically. With the ever increasing pressure of population in the country there is a constant tendency for cultivation to spread into the drier areas. This entails the risk of rapid destruction of the vegetative cover and the onset of soil erosion, unless a permanent, balanced system of farming is maintained. It is particularly under such conditions that pasture and livestock are indispensable for the farmer.

Introduced Pastures

Introduced pastures are artificially established grasslands in which productive and palatable species suitable to the area are grown. These pastures may either be permanent or temporary. The latter are those fitted into the cycle of crop-production. The establishment, utilization and management of introduced pastures demand a higher standard of farming skill than in the case of natural grassland, but it does not in any way call for more managerial skill than for instance the production of other crops. Extra efforts in connection with grassland farming are always well repaid by greater productivity and consequent improved soil structure. In general it can be said that the farmer who wants to maintain his grassland at the highest possible level of production year after year has to regard his grass sward as a major crop—a fact that is almost unheard of in Ceylon to-day.

During recent years more and more attention has been focussed on livestock keeping and pasture production. The vital necessity for a periodical soil cover in the crop rotation is being increasingly recognized. A soil cover would induce the recovery of soil structure and provide an opportunity for the accumulation of organic matter directly and also indirectly by the concentration of animals on the land. It would be most desirable if this aspect of farming is given more prominence when new land is opened up for cultivation. Grassland farming could, in fact, be introduced with great benefit as a preliminary step of land use in all new settlement schemes.

Success of Signal Grass

The Department of Agriculture has for several years conducted trials in order to find grasses and legumes well suited for the different zones of the Island. In the search for plants suitable for pastures the following factors are of great importance :—palatability, productivity, ability to provide a good soil cover and stand periodical drought, ease of eradication if required, ability to recover from intensive use and the ability to withstand special natural condition. Many valuable results have been obtained during years of trial, of which the success of *Brachiaria brizantha* or Signal grass is outstanding. The introduction of this grass has in fact revolutionized grassland farming in the country and it is sure to play a very important role in the future agricultural economy. It was only about 5 years ago that the Department introduced it starting with a single plant. This one plant has since by vegetative propagation been the basis for the establishment of some 10,000 acres. Prior to the arrival of Signal grass there was only a very small acreage which could be termed as improved-introduced pasture. The success of this grass has given considerable encouragement to grassland farming, and it has definitely helped to make many planters and farmers "pasture minded". Somehow this grass seems to have found a second and ideal home in Ceylon, it is not so outstanding in East Africa from where it originated.

The qualities that make Signal grass unique are as follows :—

(1) It is easy and cheap to establish (by cuttings).

(2) It competes easily with all types of weeds and does not need frequent weeding as do most other grasses and fodder plants hitherto in use.

(3) It is very resistant to drought, and can, if well managed, be lightly grazed during dry periods.

(4) Its mat-forming habit of growth makes it an excellent soil and water conservator and fertility builder.

(5) It is high yielding and relished by all types of stock. It can be used for pasture as well as soilage and makes excellent hay or silage.

(6) It grows well under shade. This ability should be exploited in coconut lands and in the dry-zone forests.

(7) It can be grown under a wide range of climatic conditions and in different types of soil. It has been successfully grown in the dry-zone, wet-zone and up to an elevation of 4,000 feet. It does not tolerate water-logging.

Signal grass does not produce more than a very small percentage of viable seed, but its establishment by cuttings is easy and cheap, as it can be ploughed in by tractor or bullock drawn ploughs. In weed infested areas this method of establishment is usually more successful.

In *Brachiaria brizantha* and the well known Watergrass (*Brachiaria-mutica*) a solution has been found temporarily both for well drained lands and for waterlogged areas as far as grasses are concerned. While investigations will be continued in order to search for still better plants the farmers have got something in hand really worth while going ahead with.

Planting *Brachiaria brizantha* cuttings

Pasture of *Brachiaria brizantha* at Polonnaruwa Livestock Farm

Legumes in Pastures

But while a satisfactory solution has been found in respect of pasture grasses, what is the position in regard to legumes in pastures? The present position is, that while it has been easy to find legumes which mix well with grasses for a short period, it has been difficult to maintain a mixed sward of grasses and legumes over several years. Generally the maintenance of a stand of vigorous legumes in a sward is considered an important objective where farm animals are raised, so much so that some people have often considered it a "must". But new developments within the field of grassland research seem to indicate that it is a point which has been overemphasized. In fact, there is evidence that a high level of production can be obtained from pastures without an intimate mixture of legumes. The greatest advantage of legumes is their ability to fix atmospheric nitrogen. Although this nitrogen is used primarily by the legumes, it also promotes a marked increase in the growth of the associated grasses. Legumes also increase the nutritive value of the forage by virtue of their high protein and mineral content. But against these advantages one must consider the following:—

(*a*) legumes are difficult to maintain in long leys, particularly during dry seasons.

(*b*) the inclusion of legumes in pasture swards calls for a comparatively high standard of managerial skill which is not yet commonly available in this country.

(*c*) grass-species are generally more productive than legumes.

(*d*) the resolution of the problem of using the legume or fertilizer as a source of nitrogen is one that will be influenced greatly by economic conditions.

(*e*) one way of supplementing the grass with nitrogen is to feed grazing stock on oilcakes; this should be given considerable thought here where oilcake is a by-product of the coconut industry and is available very cheap.

(*f*) experiments carried out in other tropical and sub-tropical areas have indicated that cultivation of grasses and legumes separately offer good possibilities and call for less skill in management.

The whole question of the importance of legumes in pastures is however somewhat academic at it is not a question of one or the other, but only of how far this would influence the rate of pasture development here. There is no doubt that mixed swards will be as common here as in the temporate zone countries the moment suitable legumes are evolved, but until such time there are alternative approaches to the problem of maintaining and adequate supply of nitrogen for stock. Ceylon is comparatively rich in naturally occurring legumes, many of which are able to compete with the heavy sward of *Brachiaria brizantha*, and there are several introduced legumes which show great promise e.g. Tropical Kudzu (*Pueraria phaseoloides*), *Indigofera endechafylla*, *Stylosanthes gracilis*, *Desmodium scorpiurus* etc.: So the problem of growing mixed swards in Ceylon is not so bleak as it sometimes is made out to be.

Mention should also be made of the numerous fodder trees found in the country. Such trees can play an important part in livestock production especially during dry seasons. The

nutritive value of their leaves is high and they can be of great value also as shade trees in pastures.

Pasture Management

The productive capacity of pastures depends upon several factors, the most important being—soil and climate, species grown, type of animal and management. Optimum production is possible only when these factors are in equilibrium with each other. Of these factors, management is the most variable because it depends on the practical skill of the farmer. Grassland management should aim not only at maximum production and maintenance of the grass sward, but also at the best possible utilization of the forage once it has been grown. Management practices will, of course, have to differ considerably according to local conditions, but here are some general principles which are applicable to most parts of the country.

Rotational grazing of grassland—short periods of grazing followed by periods of recuperation—should be the rule because such controlled grazing, both on natural and introduced pastures results in better utilization than free range grazing. The purpose is to confine the animals to one area at a time so they will eat off the forage more evenly and with less waste by trampling and selective grazing.

Rotational grazing presupposes proper subdivision of existing grassland by fencing or the employment of herdsmen. But although this tends to add to the cost of the forage it is a system which pays good dividends because it almost certainly results in increased production and improved quality of the feed. The number of subdivisions required will depend on the type of stock, size of herd, and the productivity of the land with due regard to access to drinking water for stock.

In regard to *Brachiaria brizantha* pastures it has been found that a system of "high grazing" and frequent rotation of the grazing stock has proved very successful. By "high grazing" is meant that the herbage should not be grazed lower than 6 inches. By then the animals will have consumed the tender and highly nutritious growth. "High grazing" results in a more uniform production throughout the year, produces higher yields of nutritious forage and, above all, gives maximum soil protection thereby helping to conserve moisture during dry seasons.

On natural grassland the danger of over-grazing must always be kept in mind. Over-grazing results in favouring the less palatable and the low growing species at the expense of the better species and, if continued, will quickly deplete the sward and finally the soil will become almost useless for plant growth. On introduced pastures continued over-grazing results in the breakdown of the grass cover and replacement by weeds.

The utilization of grass is closely linked with its production. Many of the practical difficulties arising in connection with proper use of grass relate to seasonal growth and to the fact that the period of maximum growth coincides with the development of stem and consequent fall in nutritive value of the forage. This problem is of particular importance to grassland farming in the dry-zone. By good and well planned management, the grazing season in the dry-zone can be considerably extended, but the fact still

remains that approximately three-fourths of the forage is produced during the period from about October to May and this makes it impossible to obtain a close fit between the pattern of grass growth and the nutritional requirements of livestock unless part of the production during the season with lush growth is conserved as hay or silage. If conservation of surplus forage does not take place the stocking rate will have to be reduced thus resulting in lowered production per acre. It is on this basis that the farmer must arrive at some decision about livestock numbers in relation to the pasture supply. Of the managerial factors the stocking rate is perhaps the most important because the grazing animal itself can be of prime importance in building up fertility of land. If an increasing number of animals are carried on a pasture for a greater number of days more and more dung and urine are added to the soil. This, in turn, improves the soil and raises its cropping power. A gradual increase in stocking rate can only be achieved if pastures are well cared for, because, as in respect of other types of production, it is easy to plan for stagnation, but difficult to plan for progress. The tradition that keeping livestock always improve the fertility of the land is only relatively true because livestock do not return in the form of manure all that they have consumed. Land fertility is built up by livestock, however, in cases where the stock is fed supplementary feeds such as coconut cake and kept on well covered pastures so that very little of the value of their droppings is lost. Similarly in a system of mixed farming the fertility of cultivated fields can be improved by applying manure produced from pasture and cakes. In some areas, for instance in up-country *patana* lands, serious soil deficiencies exist which can only be overcome by a regular supply of fertilizers.

Management practices should always aim at maintaining a good soil cover throughout the year by adopting a correct grazing technique and ensuring good root development. There are two implements which are very useful in this connection, viz., the mower and disc-harrow. Mowing once or twice per year can help to keep the plants at a uniform stage of growth. Disc-harrowing helps to spread droppings from stock and to improve root-development.

Well maintained grassland and the associated animal husbandry (if given their proper place in Ceylon's agriculture) could indeed influence heavily the yield of arable crops. In fact grassland farming is adapted from nature's way of providing food and conserving the valuable top soil. In grassland farming therefore lies one of the country's greatest opportunities for expansion of food production.

References

GORDON J. Enclosure and Land Settlement and the evolution of West African Agriculture—*Tropical Agriculture,* Vol. 31, No. 4, 1954.

EDWARDS D. C. The Impact of New Grasses on Agricultural Development in East Africa —*Tropical Agriculture,* Vol. 31, No. 3, 1954.

JOSHI N. R. & PHILLIPS A. W. F.A.O. Zebu Cattle of India and Pakistan—*Agric. Study,* No. 19, 1953.

Improvement of Livestock Nutrition under Tropical Conditions. (Report of the F. A. O. Meeting of Livestock Production under tropical and sub-tropical conditions, held at Brisbane, Australia, 1955.)

A Survey of Agricultural Conditions in the North-Western Division

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THE NORTH-WESTERN DIVISION comprises the whole of the North-Western Province and consists of two revenue districts—Kurunegala and Chilaw/Puttalam.

The area of the Province is 3,016 square miles, of which 2,992 square miles make up the total land area.

The acreage of this total land area is 1,914,960. Of this 40.48 per cent. is cultivable and 32.22 per cent. is cultivated (Statistical Abstract of Census and Statistics 1954.)

The rainfall during 1954 was well distributed. There was no crop failure due to drought, although there was a fair amount of damage to paddy by floods in the wet zones of the Province.

The total rainfall varies from 50-85 inches in different districts. The Province can roughly be divided into three climatic zones viz. wet, intermediate and dry.

The wet zone falls within the Dambadeni Revenue District, the whole of Weudawilli, Hirigala, Walgampathu Korale, and the south of Pitigal Korale South.

The dry zone comprises the whole of the Puttalam District and the northern half of Pitigal Korale South in the Chilaw District ; also, the whole of Wanni Hatpattu, Mariyawatte Korale of Dambadeni Hatpattu, Kirigama and Karandapath Korales of Katugampola Hatpattu and Polpitigama and Moragallagama in the Hirigala Hatpattu.

The intermediate zone is really Dewameda excepting Walgampathu Korale.

Water Resources

A large number of tanks (*wewas*) both large and small exist throughout the Province, except in Dambadeni Hatpattu of the Kurunegala District and Pitigal Korale South in the Chilaw District ; about 25-30 per cent. of these are functioning. In recent years, however, Government has taken in hand the restoration of a large number of abandoned tanks. In Hirigala Hatpattu two major tanks are under restoration. These, together with the newly restored tanks in Wanni Hatpattu, Abakolawewa, Attaragalla, and Palukadawela will bring a very large acreage of paddy under an assured supply of water in the dry zone.

Some of the major irrigation tanks in the Province are—

(*a*) *Kurunegala District*

Batalagoda Tank
Magalle Tank (R. B. E. Colony)
Nikaweratiya
Galagamuwa Tank
Abakolawewa Tank
Attaragalla Tank
Palukadawela Tank
Mediyawa Tank
(Colonisations)
Siyambalagamuwa (Colony)

(b) *Puttalam District*

Tabbowa Tank (Colony)
Uriyawa Tank (Colony)
Maha Uswewa (Colony)
Kottukachchiya (Colony)
Maha Kumbukkadawela Colony

(c) *Chilaw District*

Katupotha Tank (Colony)

In ancient times there were channels that connected a storage tank with a large number of small subsidiary tanks. The storage tank was sited in a favourable catchment, and the water from this was never used for direct irrigation. This system no longer exists and the old connecting channel traces are not found. As a result, a large number of small tanks in the dry zone cannot store sufficient water to ripen a crop.

The Attaragalla scheme provides an illustration of the old system of irrigation. A dam has been built across the Maoya and this water finds its way into Abokolawewa. The excess water of Abakolawewa flows into Attaragalla and the excess water of this into Palukadawela tank. Further restoration of tanks in this link are contemplated by the Irrigation Department.

Labour

In areas where colonisation schemes exist, or where there are major irrigation tanks, labour, for operations like transplanting is difficult to come by. This is particularly so in and around Bathalagoda, the Magalla tank, Tabbowa and Kottukachchiya tanks. The period of sowing in these areas and in the dry zone in general is limited. The time to start sowing and the last date when water will be issued are decided at "cultivation meetings". Then there is a rush for whatever labour is available.

A labourer may be paid up to Rs. 5 per day with mid-day meal. For transplanting the usual rate is Rs. 25 per acre for a team of 6 to 8 women. In the Bathalagoda area the rate is as much as Rs. 40 per acre.

In certain parts of the Province, particularly Dambadeni Hatpattu, owing to this cut-throat competition for labour, the old *kariya* system is gradually returning. In this system, all the women in a *yaya* join forces in transplanting. The owners of the fields provide the mid-day meal, tea and betel.

The demand for labour by the Land Development and Irrigation Departments, where new lands are being opened or where major irrigation works are under construction, increases the difficulty of obtaining labour for paddy cultivation in the dry zone.

Land Tenure

Throughout the Province the *ande* system of paddy cultivation exists. An absentee landlord employs a tenant farmer to cultivate his fields on a share basis. The division of the produce, however, varies in different localities, viz. :

1. The commonest is the half-share system, after 20 per cent. of the harvest has been given to the *vel muladaniya*. If the owner supplies the seed paddy, this quantity is returned to him with his half-share.

2. In other areas like Devameda, three quarters of the produce is taken by the owner, but he supplies the seed paddy and the buffaloes for ploughing and other operations.

3. The absentee landlord employs a middleman or *gambaraya*, who exploits the tenant farmer. This system is fortunately confined to small areas in Weuda Wil Hattpatuwa only.

4. The division of the produce is on the half-share basis, but the owner deducts the value of seed paddy, the hire of buffaloes and plough, &c. The share of the tenant farmer is so reduced, that he is perhaps able to feed his family for a few months only.

The "ande" system is prevalent largely in the wet districts ; in the dry zone most cultivators farm their own lands acquired by inheritance or marriage. Most often cultivators own more land than they can cultivate in one season, hence, even in the best years of rainfall a fair acreage in the *wanni* remains uncultivated in the *maha*.

With the price of paddy guaranteed at Rs. 12 a bushel, the older practices of the *ande* system are fast dying out. A tenant farmer is now satisfied with taking on a small extent of land as he gets a higher yield with the adoption of improved practices. Many absentee landlords now supply seed paddy, fertilisers, transplanters, &c.—the cost of which they do not deduct from the tenant farmer's share. Because of the increasing difficulty of getting tenant farmers, many owners are satisfied with a quarter of the share, in addition to supplying seed paddy, fertilizers, &c.

Agriculture

The crops from which the Province derives its wealth are coconut and paddy—420,383 and 138,840 acres respectively.

Rubber occupies 17,500 acres, mainly in the wet Kurunegala District.

Tea covers an acreage of only 623 in Weuda Wili Hatpattuwa, bordering on the Central Province.

Chena cultivation (7,849 acres) is confined to the dry zones in the Wanni Hatpattu, in parts of Hirigal Hatpattu, Demala Hatpattu, Puttalam Hatpattu, &c.

The interests of coconut and rubber are looked after by the Coconut and Rubber Research Schemes respectively. Field officers of the Department of Agriculture assist small holders in pegging out contour bunds, &c.

Extension officers of the Departments of Agriculture and Food Production concentrate on paddy and to a lesser extent on other annual crops and animal husbandry.

Pure-line Paddies

The Division is well provided with pure-lines. *Podiwi a-8* and *Ptb 16* are the long aged varieties under cultivation. *Podiwi a-8* is being gradually replaced by *Ptb. 16* which is higher yielding, although in Pitigal Korale South, *Podiwi* is still preferred for its small grain.

Of the short-aged paddies there are the following : *Vellai-illankalayan 28061* and *Murungakayan* (4 months), *Mas M. 24* (5 months) an Indonesian variety and *Pachchaiperumal 2462/11* and *Wani Dahanala* (3 months). *Murungakayan* is replacing *Vellai-illankalayan* as it is a higher yielder. *Mas*, though very good, is restricted to the Bathalagoda tract, where a 5 month variety can be grown during *yala*. *Wani Dahanala* is preferred to *Pachchaiperumal* as a short-term *maha* crop.

Pureline Extension Scheme

Mr. V. S. Perera, one time Senior Assistant, Wariyapola, and now retired, evolved a very practical scheme of Private Seed Farmers by enlisting the support of *vel muladaniyas*. There are in the province 1,500 *vel muladeniyas*. They are now the Private Seed Farmers for their respective *yayas*, and their fields the demonstrating centres for the improved methods recommended by the Department.

Mr. Perera worked out details for each *yaya* under a *vel muladaniya* on a three-year pure-line paddy scheme. If a *vel muladaniya's yaya* has an extent of 100 acres he would need 200 bushels seed paddy at 2 bushels per acre. To raise this quantity he would need, in the previous year 16 bushels to be sown on 8 acres at a yield of 25 bushels per acre. Therefore, in the first year the seed paddy a *vel muladaniya* needs is only 3/4 bushel which will produce the seed paddy for the second set of multiplication farmers for the 8 acres. On this basis, every *vel muladaniya* is sold every season pure-line seed paddy produced on a departmental farm sufficient to raise seed on his field for a second set of multiplication farmers. The *vel muladaniya* gets Re. 1 as a premium for every bushel he sells or exchanges with a second set of multiplication farmers on a signed list and not on what he produces. This scheme has been in operation since the *maha* of 1950-51 and although 100 per cent. success cannot be claimed for it, the spread of pure-lines in the Province is entirely due to this scheme. There are many advantages in this scheme. No transport, handling and storing is involved and as a result no losses occur, nor have there been any complaints of bad germination. Before the premium is paid and the seed paddy is allowed to be sold or exchanged, samples are taken and tested for germination and purity and a certificate issued, signed by the Agricultural Officer himself. For every season the seed paddy requirement of each variety is known and can be multiplied on departmental farms within the division or booked for multiplication with other farms outside the division well in time. Seed farmers do not change from year to year or season to season. A gold, silver, and a bronze medal is offered every year for the *maha* season to the three best *vel muladaniyas*, who have the greatest extent under pure-line, for extents transplanted, manured, weeded or crop-harrowed. This offer of medals has created healthy rivalry and helped in the spread of pure-line seed paddy and improved practices.

Transplanting

There are now trained transplanters in practically every food production range. A team of 6-8 women can transplant an acre in a day. These teams go out on hire at Rs. 25 an acre anywhere within a district. Competitions for transplanting, organised in each food production range for teams of women put forward by *vel muladaniyas*, have helped to train these teams. If there is water every owner will now transplant his fields. It is only in Wanni Hatpattuwa that this practice has not spread fast enough.

The Japanese method of transplanting was commenced during the *maha* of 1954-55 in demonstration fields in every range. In *maha* 1955-56 a considerable acreage was transplanted by this method, particularly under the Batalagoda tank.

Light Iron Ploughs

The plough in use throughout the province is the light iron model "D". This model is turned out by several local blacksmiths at Rs. 9, complete with wooden handle and beam, as against Rs. 12.50 charged by the Government Factory. The Co-operative Agricultural and Sales Societies handle the sale of these ploughs.

Burmese Harrows

For *maha* 1950-51 every *vel muladaniya* was asked to make himself a Burmese harrow. A large scale diagram of the harrow was distributed to each *vel muladaniya* and Rs. 8 was paid to each one who got one made from food production funds. The harrow remained the property of Government and was taken on the stock book of the range officers until they were written off. These harrows were on loan to the V.VV. for demonstration purposes. Many cultivators made harrows on this pattern for themselves. No harrows have since been supplied by Government.

Artificial Fertilizers

The recommended mixtures are supplied at subsidised rates to cultivators through the Co-operative Agricultural and Sales Societies. There is a very big demand for these manures except from cultivators in the Wanni Hatpattuwa. Many cultivators in the wet zone now prefer to buy superphosphate as a basal dressing and sulphate of ammonium as a top dressing.

SPREAD OF IMPROVED PRACTICES

Kurunegala District	*Pureline acres*	*Transplanted acres*	*Crop harrowed acres*	*Pureline Paddy used*
Yala 1952	1,423	35	2,456	2,408
Maha 1952-53	12,248	6,238	5,039	13,454
Yala 1953	2,665	71	959	5,331
Maha 1953-54	48,512	6,447	10,977	97,024
Yala 1954	10,256	342	9,144	20,512
Maha 1954-55	51,020	16,904	8,756	102,040
Puttalam and Chilaw District				
Yala 1952	618	—	1,209	1,148
Maha 1952-53	2,172	153	4,720	1,870
Yala 1953	689	25	54	1,378
Maha 1953-54	2,344	272	853	2,678
Yala 1954	2,624	204	614	2,624
Maha 1954-55	4,148	520	597	8,296

Pests and Diseases

Stem borer continues to be the worst pest of paddy in the province on long-aged paddies. Other pests which are common are the paddy bug and swarming caterpillar which are easily controlled by spraying.

Rat damage is assuming large proportions in the Balalagoda area in Hirigala Hatpattuwa.

Other Crops

A concerted effort is being made to increase the acreage under onion and

chilli by holding competitions for attractive prizes. Some results have been achieved, particularly in the Talwatte model village in Dambadeni Hatpattu and amongst young farmers in the Dewameda. They now grow their own requirements of these commodities and have an excess for sale. There are 61 Young Farmers' Clubs in Dewameda with a membership of over 1000 girls and boys. Every young farmer has a plot of onion and chilli.

For large scale cultivation of onions and chillies, Kalpitiya in the Puttalam district offers the best opportunities. The soil is ideal for growing both these crops. The draw back is the lack of irrigation facilities. Funds for sinking wells have been provided by the Director of Food Production and with the installation of small hand pumps a big acreage can be brought under cultivation. The growing of capsicum chillies is very profitable as there is a ready market. Therefore the change over to Tuticorin chilli production is a little difficult. If only a central organisation like the Co-operative Agricultural and Production Sales Society can buy the ripe chilli, and handle the curing, growers will readily take to growing Tuticorin chillies.

In Hirigala Hatpattu, where cigarette tobacco is cultivated Tuticorin chilli is grown as an inter crop. This practice is extending as no extra cost is incurred except to raise nurseries and transplant. Attempts to induce cultivators in the dry zone to grow chilli on their paddy fields during *yala* failed because of the stray cattle nuisance.

Home Gardens and Chenas

Every home garden in the wet zone grows vegetables, pulses and yams, except in Pitigal Korale South, where this is not possible because home gardens are small and livestock like pigs and goats are reared.

In the dry zones the homesteads are all clustered near a tank (*gangoda*) and within this area there is very little space to grow any home garden plots. All the subsidiary crops are grown for *maha* on chenas where a miscellany of crops are grown broadcast. For *yala*, gingelly is grown on these same chenas. No planned production is possible under such conditions. The chief crops on a chena for *maha* are kurakkan, mustard and maize. Green gram, cowpea chilli, *watakka* and ash pumpkin are grown mixed with the kurakkan and mustard.

Colonists can contribute towards the growing of food crops like green gram, cowpea, onion and chilli, but they are busy with their paddy cultivation early in the season and by the time they are free the season for growing highland crops is past. Under the R. B. E. extension scheme the Land Development Department soil conserved highland allotments by machinery as an experiment. The cost however was too prohibitive for Government to do this work by machinery.

Snake Gourd

This is a popular vegetable. Its cultivation is carried out on an extensive scale in Dambadeni Hatpattuwa, Hirigala, and to a lesser extent in Dewameda. An acre of snake gourd is said to bring in a profit of Rs. 1,000.

In Dambadeni Hatpattuwa high and unirrigable paddy plots are converted into snake gourd gardens and enclosed with cadjans. Heavy manuring is also

carried out with a vegetable mixture the growers obtain from Baur & Co. or the Colombo Commercial Co. With increased transplanting of paddy these snake gourd beds are now used for raising paddy nurseries in the first instance.

The fruit fly is very severe on the gourds. Growers now have learnt to grow a catch crop of bittergourd which fruits early and attracts the fly. These are collected and buried. Arcotine is also used against this pest.

In Hirigala and Tambagalla Colony, colonists grow snake gourd in between coconut with very good profits. This helps to keep down Illuk, a pernicious weed and it also benefits the young coconut palms with the residual effects of the manure and the constant tillage given to snake gourd.

Cigarette Tobacco

This crop has been grown in Dewamedi Hatpattuwa for a very long time. In the beginning the Ceylon Tobacco Company bought green leaf at fixed prices and cured the green leaf at two or three central depots where they had erected barns. They raised seedlings which they sold to growers and also assisted growers with manure at subsidised rates. In recent years this company has withdrawn from the green leaf purchase scheme. They have also leased their curing barns. They are now only interested in the purchase of the cured leaf, graded at guaranteed rates at their central depot in Kurunegala. They loan to growers who wish to erect their own barns, the furnace, roofing material and flue pipes, the cost of which is deducted from the cured leaf in six or seven instalments. The total cost of all this material is about Rs. 2,000. Cigarette tobacco is also grown in Gonewatte, Hiripitiya, Moragallagama and Polpitigama in the Hirigala Hatpattuwa of the Kurunegala District and in Dewala Hatpattuwa of the Puttalam District.

In the Wariyapola area of Dewameda there are no definite seasons for the growing of tobacco. Because of the substantial profits that accrue cultivators grow it during any time of the year. For several years the Tobacco Officer of the Department of Agriculture has been endeavouring but with little success to restrict the cultivation of tobacco either as a *maha* crop on highland or as a *yala* crop on paddy land. The result has been the deterioration of the quality, the increase of pests, particularly stem borer, poor yields and poor prices obtained for the cured leaf.

Manioc

There is a tapioca factory at Munnaswaram in the Chilaw District. This factory buys manioc delivered to the factory at 9 cts per lb. or at prices varying from 4 cts. to 5 cts. depending on the distance of transport. They favour the Philippine variety for "sago" manufacture. Manioc that cannot find a sale locally is now sold to this factory.

The following is an estimate of guaranteed-price-crops grown in the Province during *yala* 1954 and *maha* 1954-55.

	Yala 1954 Acres	Maha 1954-55 Acres
Kurakkan	1,217	11,945
Maize	130	3,722
Sorghum	70	292
Green Gram	1,786	3,478
Bombay Cowpea	746	981
Mustard	46	604
Gingelly	14,076	34
Onion	489	770
Chilli	1,653	3,369
Coffee	151	100

Kurakkan is grown in chenas during *yala* in Hirigala and in paddy fields in some areas.

Gingelly is grown for *maha* in the wet zone in new clearings. Sorghum is mostly grown in the highlands of the Tabbowa Colony.

Livestock

The livestock population of the Province is given below (Census Report 1946).

The cattle population is to be found on coconut estates and as large herds of uncared for scrub animals found straying throughout the dry zone, particularly in the Wanni Hatpattu of Kurunegala and Puttalam Districts. The greatest number of buffaloes are also to be found in the Wanni Hatpathuwa. Goats are found in large herds, owned mostly by Muslims and Tamils, in Dewamedi, Hirigala and Wanni Hatpattuwa of the Kurunegala District and in the Puttalam District. They are looked after by herdsmen who drive the herds into the jungles for feeding by day. There is a big sale of goat manure to coconut estates for manuring. In Pitigal Korale South, in the Chilaw District, smaller herds of local and cross-bred goats are reared both for milk and meat. The pig population of the Province is mostly to be found in Pitigal Korale South where every home has a few pigs. The largest number are of the local, small, black breed. Berkshire, All Blacks and Crosses are also found, especially in coconut estates where pig keeping is being developed on a large scale.

There were always large numbers of cattle on estates, maintained more for manuring purposes than for breeding and milk. A few estates that maintained good dairy cattle, mostly of the Indian

District	Cattle	Buffaloes	Goats	Pigs
Kurunegala	198,906	103,269	22,026	4,274
Puttalam	23,468	5,221	4,181	504
Chilaw	50,980	4,902	6,526	21,084

breeds, could find no sale for the milk, except small dairies in towns like Kurunegala, Marawila and Nathandiya. A census of milk production on estates in the Katugampola Hatpathuwa, revealed that in the morning alone about 2,000 bottles were produced. Of this quantity only about 200-300 bottles found a sale at 25 to 30 cts. a bottle in nearby bazaars and at Kuliyapitiya.

With the exemptions given by the Estates Food Production Ordinance to Estates that keep livestock in lieu of growing food crops and with the establishment of the Milk Board there has been a general desire on the part of large estates to run dairies and to grow pastures under coconut. In a few years there should be a large number of well managed dairies in the Province producing large quantities of milk for sale to the Milk Board. The Milk Board has opened up a buying centre at Nathandiya in the Chilaw District. It is the intention of the Milk Board to open another centre at Kurunegala in the very near future complete with pasteurising plant. The demand for artificial insemination is increasing. The Department has centres at Marawila, Nikaweratiya and Kurunegala for this purpose. In addition departmentally bred bulls are loaned to estates and Rural Development Societies for stud services.

Poultry

Extension in poultry rearing is only possible amongst the Muslims, Tamils and the Christians. In Pitigal Korale South, which is predominantly Catholic, poultry rearing is being carried out on a large scale. Setting eggs and departmentally bred cockerels, Rhode Island Red Australorp and White Leghorn, are sold to bona fide villagers at a concession. There are two Livestock Breeders Associations in the Province, in the Kurunegala District and in the Chilaw District. These are affiliated to the All Ceylon Cattle Breeders Association. Annual livestock shows held in these two districts have contributed in large measure to creating an interest in animal husbandry. The Animal Husbandry Section of the Coconut Research Scheme has co-operated with the Field Officers of the Department of Agriculture in making available setting eggs for issue to villages.

Orange Group Estate, Polgahawela, has started to cure bacon on a modest scale. Estates in the district that find it difficulty to sell their pigs for slaughter may well profit from this pioneering venture.

Marketing

The Marketing Department has established buying centres for eggs at places where eggs are available in quantity. They buy eggs at prevailing market rates which fluctuate between 14 & 22 cts. To enable the Department to introduce better breeds, the Marketing Department should buy graded eggs. Today they buy eggs ungraded, hence there is no inducement for poultry breeders to maintain better breeds.

There are village fairs throughout the Province on practically every day of the week at one centre or another. This enables cultivators to sell their produce within a reasonable distance from their homes and at the same time buy their requirements for the week.

An Analysis of the Polonnaruwa Herd of Red Sindhi Cattle*

P. MAHADEVAN

THE PROBLEMS associated with the breeding of dairy cattle in the tropics may be divided into two parts, those arising from climate *per se,* and those arising from low productivity of native stock. Insofar as tropical breeds of cattle like the Red Sindhi are concerned, the problems are solely those arising from low productivity, as the necessary adaptability to the hot tropical climate is inherently present in these animals. The main components of low productivity are a late age at first calving, long calving intervals, short lactations and a low average daily yield. Any attempts to increase the productivity of native cattle in the tropics may therefore be viewed as being fundamentally concerned with some or all of these components.

To produce the desired improvement in each of these traits, it is necessary at the outset to subject each individual trait to a separate investigation in regard to the operational wisdom of applying breeding in preference to other methods. The analysis that has now been made of the Polonnaruwa herd of Red Sindhi cattle not only shows the possibility of improvement of these traits in tropical cattle, but also sheds considerable light on the most efficient means of achieving this goal. Perhaps the most convincing evidence for the possibility of improvement is the high variability that obtains in respect of each of these traits in tropical cattle. The co-efficient of variation of age at first calving for instance, is 15 to 20 per cent. for most tropical cattle as compared with about 10 per cent. for temperate zone cattle. Co-efficients of variation of calving intervals, lactation lengths, average daily yields, and total lactation yields are also considerably higher in tropical cattle, being approximately 28 per cent., 24 per cent., 27 per cent. and 40 per cent. respectively in the Red Sindhi herd at Polonnaruwa Livestock Farm. With co-efficients of variation of this order it is undoubted that the progress possible would be high, provided the most efficient means of achieving the desired end are adopted.

Analyses of the repeatability of the main components of milk production in this herd yielded the following results :—

Components of Milk Production	*Repeatability*
Average daily yield	+0·46
Lactation length	+0·18
Calving interval	+0·15
Dry period	+0·10

* Interested readers are referred to a more comprehensive technical study of this subject which has been published under the title "Population and production characteristics of Red Sindhi cattle in Ceylon" in the Journal of Dairy Science Vol. XXXVIII, No. 11, 1955, 1231-1241.

Records of over 300 cows were used in arriving at each of the above estimates, so that the sampling errors were small. It would appear from these estimates and from other evidence published elsewhere, that whereas the improvement of some of these traits is largely a matter of better feeding and management, in others sufficient genetic variation may still exist after optimum non-hereditary conditions have been established to warrant the application of breeding methods of improvement. Age at first calving, length of calving interval, and length of lactation may be regarded as belonging to the first category. The rapid progress that has been achieved in recent years by better management techniques in lowering the length of calving interval from 451 days to 408 days, and the results of early maturity experiments to lower the age at first calving in other tropical cattle, strongly support this conclusion that much improvement in these traits could be achieved by better feeding and management.

Average daily yield and total lactation yield on the other hand, were found to be moderately repeatable (0.46 and 0.41, respectively), with total lactation yield having a heritability of about 0.2. Selection would therefore be a useful tool in improving these characters. One might then ask to what extent selection for these characters has actually been practised in this herd. The genetic superiority of dams of cows over their contemporaries showed that the intensity of selection applied left much to be desired. As, in fact, the effective breeding period in this herd since its inception has been about 13 years, one would expect the genetic improvement to have been at least of the order of 20 to 30 gallons in lactation yield. But what has actually been achieved is an over-all negative selection pressure for yield.

The reasons for this are not far to seek. Any attempt to improve the genetic level of a herd of dairy cattle is basically dependent on the prevailing mortality rates, rearing proportions, and reproductive rates. With high reproductive and low mortality rates and with high rearing proportions, the number of replacement stock available would be high and therefore the intensity of selection possible would also be high. In the present study, it was found that mortality, as measured by the percentage of females that die before calving averaged 23 per cent. between 1938 and 1953, with a peak of 45 per cent. during 1942-45. The average reproductive rate which was measured up to 1949 as a sum of the partial reproductive rates in the different years was 0.46. This means that, on the average, every two cows produced in their lifetime only one heifer calf that came into milk in the herd. Rearing proportions during this period were also low (0.19), and it was only once in about five calvings that a cow produced a heifer which reached a lactation. In the light of these parameters, it is not surprising that no overall genetic progress has been made by selection of cows in the Red Sindhi herd at Polonnaruwa during the first 12 to 13 years of its existence.

During the period 1951-54 however, with the decrease in mortality and with the evident increase in reproductive rates and rearing proportions, intense selection appears to have been practised, and it seems probable that when all the surviving heifers from this period become incorporated in the milking herd, the probable genetic gain would be high.

The future expansion and improvement of this herd would involve keeping down mortality rates at under 20 per cent., increasing the rearing proportion to 0.33, raising the average reproductive life to five lactations and shortening the generation interval from 6½ years to about 6 years. Current statistics suggest that these are attainable in this herd. On this basis, the population may be expected to double in size every eight years without further resort to importations. This is a conservative estimate; nevertheless, it shows that even in tropical breeds there is a considerable reserve of fecundity, which, if utilised properly, would permit the population to expand rapidly.

II–The Use of Triphenyl Tetrazolium Bromide in Viability Tests of Rice Seed

J. J. NILES

THE USE of triphenyl, tetrazolium bromide as an indicator of viability and of potential germination was reported in the *Tropical Agriculturist* Vol. CX., No. 1 (Niles, 1954). The technique consisted in immersing hulled, water-soaked and longitudinally bisected seed in a solution of tetrazolium salt in the dark, to effect staining of the embryo. For the purpose of that work, a seed in which at least the entire plumule and radicle, half the scutellum and the region between the plumule and radicle stained, was considered viable. A 1.0 per cent. solution with a staining period of 1 hour was found to be most satisfactory. If the chemical was in short supply, a 0.1 per cent. concentration for a staining period of 4 hours was considered suitable. The magnitude of the correlation coefficients established the fact that the germination tests can be replaced by staining tests. It was indicated that one of the chief uses of this staining test was that even in seed which is dormant, the eventual germination capacity can be predicted with a considerable measure of accuracy.

Since the publication of the earlier work, data relating to the complete interval between the time of harvesting and the complete loss of viability have become available. Moreover, the finer points of the staining technique were worked out.

Material and Methods

The procedure adopted in the present investigations was eessntially the same as that reported in the earlier paper (Niles, 1954). Seed was hulled, soaked over-night in water at 25° C for 16 hours, and bisected longitudinally through the embryo and endosperm. Seed sections were placed, with the cut surfaces facing up, in a watch-glass and completely covered with a 0.1 per cent. solution of the tetrazolium salt. A count of the stained embryos was made after 4 hours in the dark. Treatments were replicated thrice.

Dormancy

The correlation of tetrazolium staining with germination percentage in seed that is progressively losing its dormancy is of immense interest particularly in the case of late, photoperiod-sensitive varieties, and has been the subject of investigation.

The previously reported tetrazolium tests with *Djalen* and *Panduruwi*, which have germination to flowering durations of 4½ and 5 months respectively, indicated that the eventual germination capacity of these two varieties will be 100 per cent. on the expiry of the dormancy period, this predicted germination percentage was reached by these two varieties after a lapse of 5 and 12 weeks respectively.

Fig 1. Pt b 16 (Harvested on 10-2-54)

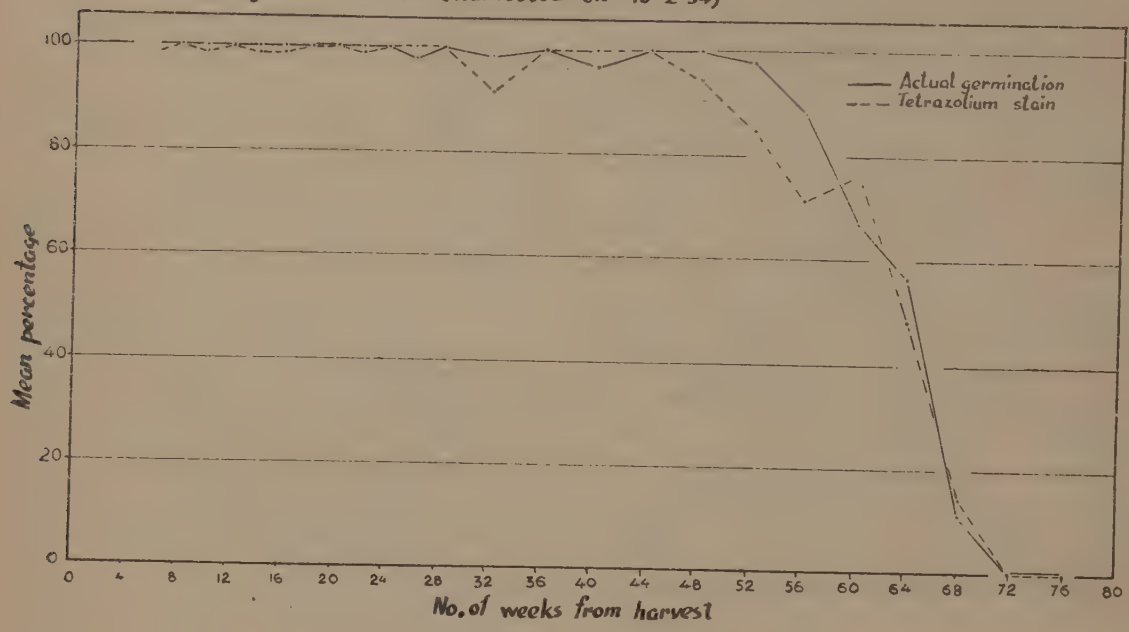
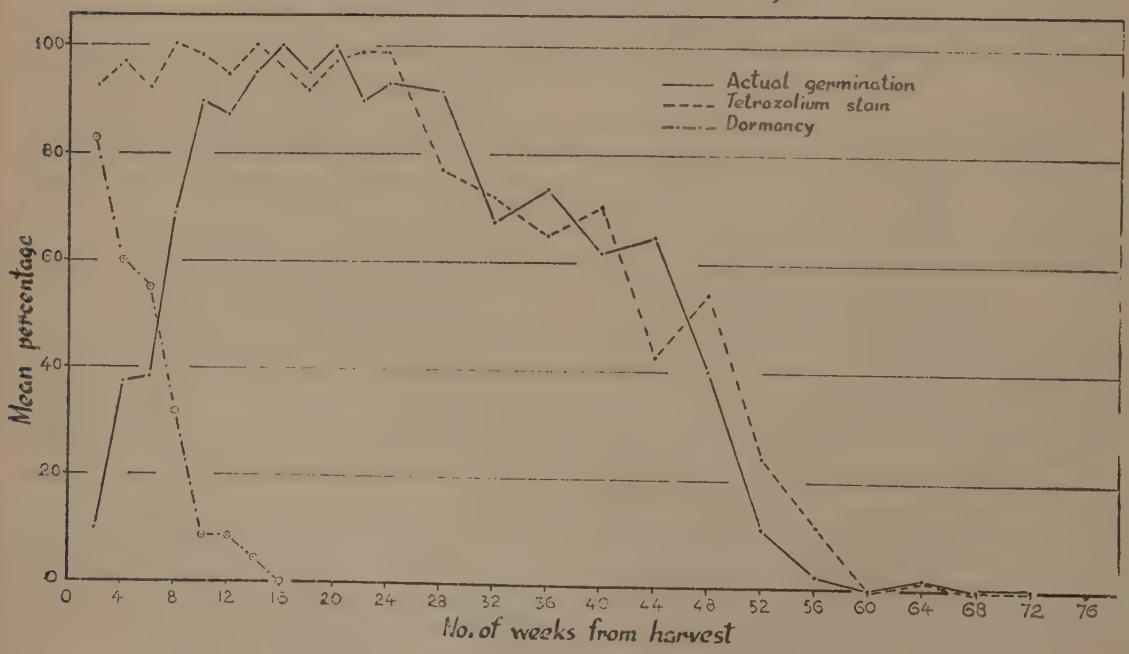


Fig 2 Mawi B-11 (Harvested on 6-3-54)



These tests of tetrazolium staining were repeated in March 1954 with the following purelines.

TABLE 1

Variety	Germination to Heading (months)	Photoperiod-Sensitivity 2c (Chandraratna, 1954a)
Kavunginpoothala Ptb 16	5	42·9
Mawi B-11	5	34·4
Molagusamba g 18	5	<34·0

The mean staining and germination percentages are plotted in Figures 1 to 3.

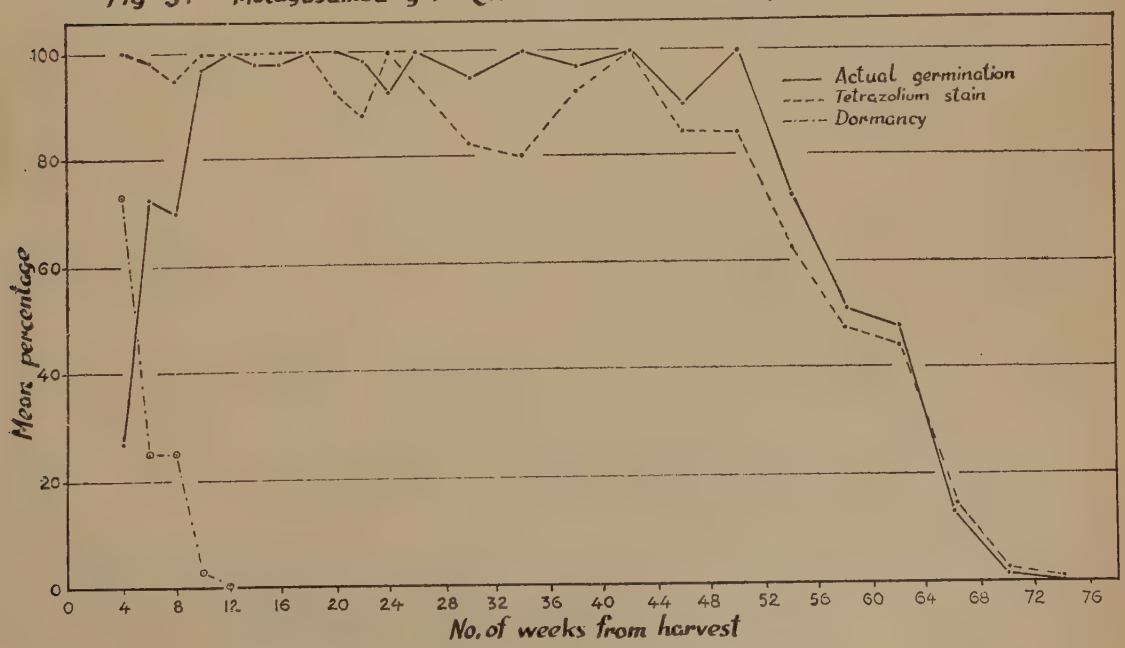
TABLE 2—Correlation and Regression Coefficients

Variety	r	b
Ptb-16	+0·987±0·005‡	+0·972±0·034‡
B-11	+0·973±0·013‡	+0·933±0·057‡
g-18	+0·982±0·008‡	+0·945±0·040‡

‡ Significant at P=0·01

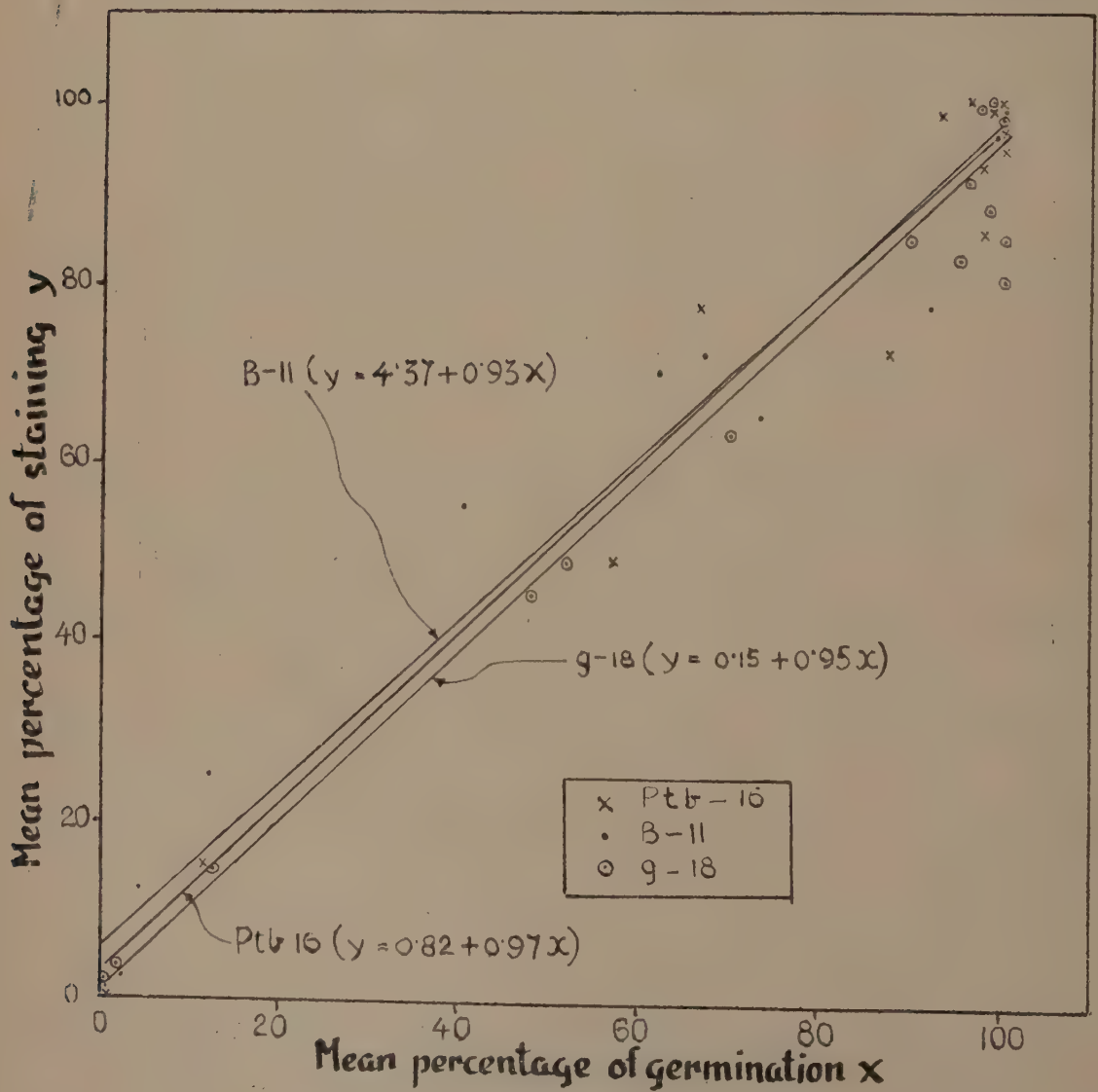
In the period preceding the complete expiry of dormancy, the staining percentages persist at a level comparable to the maximum germination percentage. On the complete expiry of dormancy, the staining and germination curves almost completely coincide. The extremely high values of r indicate

Fig 3. Molagusamba g-18 (Harvested on 21-2-54)



almost complete correlation : r ranges from $+ 0.973 \pm 0.013$ to $+ 0.987 \pm 0.005$. The staining percentage decline *pari passu* with germination : the values of b extend from $+ 0.933 \pm 0.057$ to $+ 0.972 \pm 0.034$. It is accordingly evident that tetrazolium staining is a complete substitute for a germination test for the whole life of the seed, including its period of dormancy. Regression lines fitted to the data of staining on actual germination are shown in Figure 4.

Fig 4. Regression graph of staining on actual germination



Staining Topography

In the earlier work finer distinctions based on the distribution of stain in embryo and scutellum were not drawn. Precise information was considered necessary for fuller application of this technique. Accordingly, the topographical spread of the stain in the embryo and the scutellum, traced by the failure of dead tissue to stain, was studied in relation to actual germination. Soon after the stated period of staining, each seed was examined microscopically and the location of the stain in the embryo and scutellum was mapped (*vide* Figure 5 a-f). The progressive decline of the stain in senescent seed is shown in these diagrams.

The numerical data were compared with the corresponding figures of actual germination, and the parts which should stain for indicating germination were ascertained. It was found that the seeds capable of germination stained in the plumule and radicle, the transition region between these parts and at least three-fourths of the scutellum, as shown in Figure 5 a & b. The failure of the root and the collar to stain was clear indication of non-viability.

Effect of Temperature on Staining

The desirability of increasing the rapidity of staining is evident, and the investigation described below had that objective. Seed of the pureline *Ptb—16*, with a germination percentage of 100, was used to determine the quickest method of testing. A 1.0 per cent. solution was used and the staining period was 1 hour.

TREATMENTS

1. Initial Temperature of water used for pre-soaking

a — 40°C
b — 45°C
c — 50°C
d — 55°C
e — 60°C

2. Pre-soaking period

a — ½ hour
b — 1 hour
c — 2 hours
d — 4 hours

The 20 factorial treatment combinations were replicated four times.

TABLE 3—Mean percentage of seed stained

Initial Temper of Pre-soaking	*40°C*				*45°C*				*50°C*				*55°C*				*60°C*			
	Pre-soaking period (Hours)																			
Rep.	½	1	2	4	½	1	2	4	½	1	2	4	½	1	2	4	½	1	2	4
a. ..	×	×	96	100	×	×	100	100	×	×	100	100	×	×	100	100	×	100	100	100
b. ..	×	×	92	100	×	×	96	100	×	×	100	100	×	×	100	100	×	100	100	100
c. ..	×	×	92	100	×	×	100	100	×	×	100	100	×	×	100	100	×	100	100	100
d. ..	×	×	92	100	×	×	100	100	×	×	100	100	×	×	100	100	×	100	100	100
Mean ..	—	—	93	100	—	—	99	100	—	—	100	100	—	—	100	100	—	100	100	100

× **Insufficiently softened for uniform bisection.**

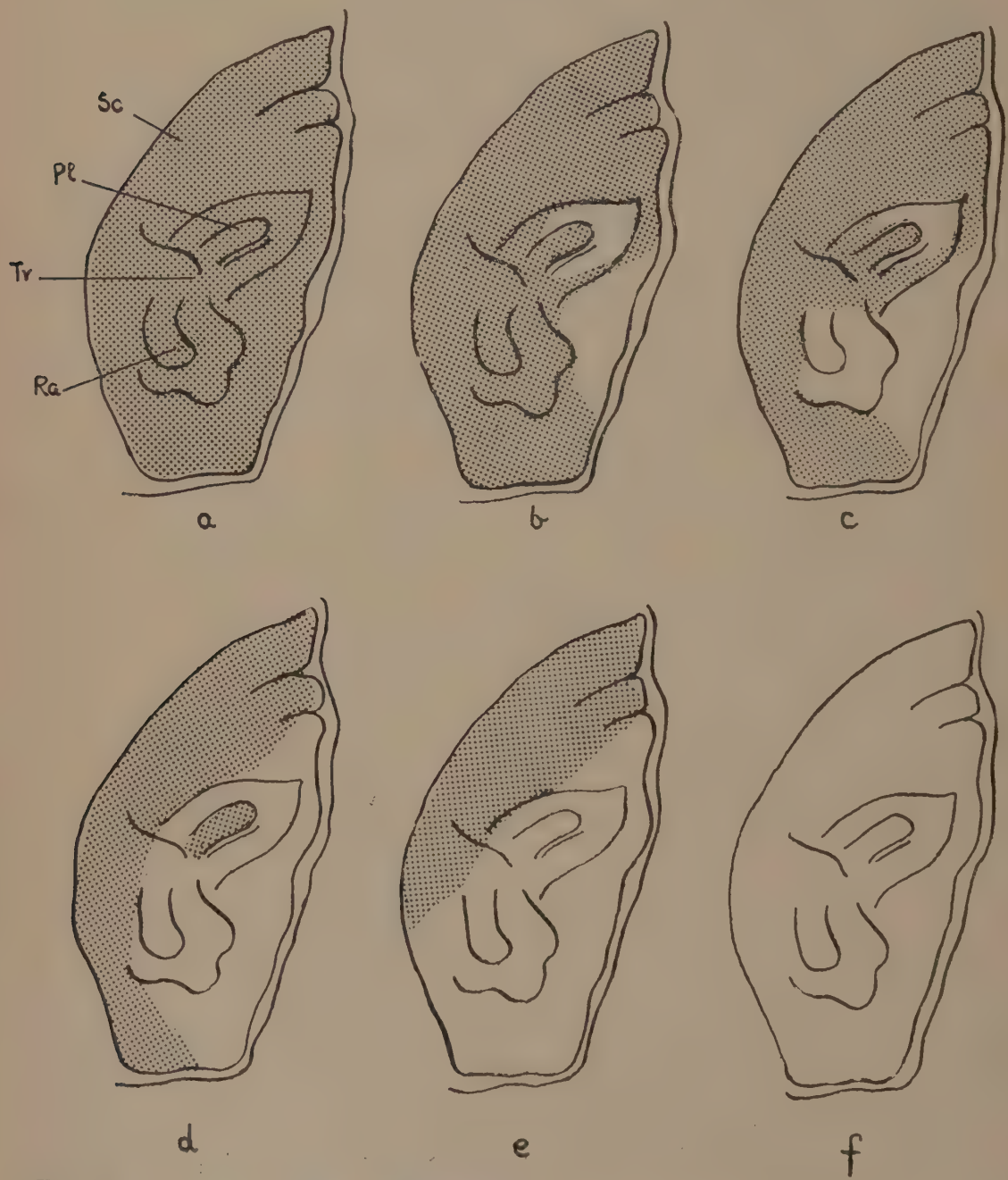


Fig. 5 Topography of staining in senescent seed. (longitudinal section of embryo)
Pl = Plumule, Ra = Radicle.
Tr = Transition region, Sc = Scutellum

It is evident from the above figures that the quickest method of testing is by pre-soaking the seed for 1 hour in water of an initial temperature of 60°C. Subsequent tests indicated that the seed was affected at this temperature. Accordingly, pre-soaking for 2 hours at a water temperature of 45 to 50°C was adopted as the most satisfactory. This modification reduces the time taken to test a sample of seed to 3 hours.

Summary

In investigations of rice varieties differing in photoperiod-sensitivity and accordingly in the duration of dormancy, it has been shown that tetrazolium staining can provide an accurate estimate of viability during the whole period extending from harvest time to the complete loss of viability.

The topography of staining in the embryo and scutellum was studied : the seeds capable of germination stained in the plumule and radicle, the transition region between these parts and at least three fourths of the scutellum.

A rapid test of viability, based on the use of high temperature, is reported.

Acknowledgment

I gratefully thank Dr. M. F. Chandraratna and Mr. L. H. Fernando for their valuable help in the preparation of this paper.

Reference

NILES, J. J. 1954.—I. The Use of Triphenyl Tetrazolium Bromide in Viability Tests of Rice Seed. *Trop. Agriculturist* CX (1) ; 13—20.

CHANDRARATNA, M. F. 1954*a*—Photoperiod Response in Rice (*Oryza sativa* L.) I.—Effects on inflorescence initiation and emergence. *New Phytologist.* 53 (3) : 397—405.

The Use of Nitrogenous Fertilizer and its Effect on Pasture Herbage

G. W. E. FERNANDO

Introduction

ECONOMICALLY, the nitrogen supply is by far the most important. It may be, and probably usually is impossible to grow good grass or legumes without the addition of lime, phosphorus, or potassium, or all of them, but it is comparatively a simple matter to supply these deficiencies. But with mineral deficiencies corrected, the most difficult problem remains, viz., that of supplying, utilising and conserving nitrogen. There are two methods of supplying nitrogen, namely, by application of nitrogenous fertilisers and by providing for its fixation by legumes or micro-organisms.

In recent years considerable attention has been given to nitrogenous manuring of grassland in order that nitrogenous fertilisers may be used to best advantage. (2, 4, 9). However, there is considerable evidence that its use is followed by a gradual disappearance of the legumes from the flora, especially if the applications of nitrogen are large. This method of supplying nitrogen needs much more study which should take into consideration all factors concerned with the permanency of desirable pasture plants and their economic utilisation.

The other method of supplying nitrogen to pasture is by natural fixation. Natural fixation has one important argument in its favour: it is nature's way of doing it. This means that the plant community which is a natural one, is receiving nitrogen in response to natural requirements rather than in response to man's desires, which, although admirable, may sometimes lead to practices that destroy rather than build.

Although, there is abundant evidence to show that both legumes and nitrogenous fertlisers materially influence the yields of herbage, opinion is divided regarding their relative contribution and value. In New Zealand great store is set by the contribution from white clover which, under conditions of intensive grazing, has been estimated to be equivalent to 2,000 lb. of sulphate of ammonia per acre and the whole nitrogen economy is almost exclusively dependent on this plant (5). In Holland increased output from pasture is only possible by application of heavy dressings of nitrogen and much doubt is thrown on the use of legumes as a source of nitrogen supply. These differences of opinion are primarily due to differences in climate and to a certain extent, differences in the types of swards or in the manner of utilising the herbage.

Under conditions of grazing, the ultimate influence of either the legume or added nitrogenous fertiliser is magnified by returns of nitrogen to the sward in the dung and urine of the grazing animal, as shown by Sears (5), and Watkin (10), when several fertility

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This article is based on an experiment conducted at the Nottingham University School of Agriculture, England.

cycles may occur in one grazing season. It is reasonable to assume that these cycles from sward to the grazing animal and back to the sward, are greatly accelerated by mixed stocking, which obviates the fouled patch. This rejected herbage must be regarded as a site of locked-up nitrogen. Furthermore, grazing prevents the crowding out of the legume which results from unchecked growth of grasses following applications of nitrogenous fertilisers.

Under conditions where the herbage is cut and carted off the field the picture is very different. Here, considerable quantities of nitrogen are removed from the field and further growth of herbage depends, amongst other things, on fresh supplies of available nitrogen —further applications of nitrogenous fertiliser, or further from the leguminous nodules if the legume can be induced to persist under these conditions.

To ascertain the contribution of white clover in an ungrazed sward, and at the same time to gather information on ancillary issues of the interaction of white clover and nitrogenous fertilisers a trial was laid down at the Nottingham University Farm in 1951. The results of this trial are mainly in accordance with published findings, but are of interest in generally supporting the conclusions recently reached by Walker *et. al.* (6, 7, 8, 9).

Eighteen treatments comprising interactions of two grasses S.24 perennial rye grass (*Lolium perenne*) and S.37 cocksfoot (*Dactylis glomerata*) with two legumes S.100 white clover and wild white clover at three levels of nitrogenous fertiliser application, namely nil (0N), 2 cwt. per acre (2N) and 10 cwt. per acre (10N), were each replicated eight times. The nitrogenous fertiliser applied was "Nitro-chalk" containing 15.5% nitrogen. Single applications of fertiliser were given each year, and during the first year plots were grazed to allow a successful establishment of the clovers. Analysis of soil samples taken prior to this application of fertiliser showed no appreciable difference in total content of soil nitrogen. The results reported here refer to the first cut of the 1953 season, when three silage cuts were taken. The principle object of this trial was to estimate the inter-relationship of white clover and nitrogenous fertiliser in the absence of the grazing animal.

The data relating to the first cut of herbage may be regarded as indicative of the happenings in any sward cut for conservation.

Results

Effect of Nitrogen on the Botanical Composition. Even before cutting the first time, changes in the composition of the sward were apparent following the application of "Nitro-chalk". The major change was a reduction in the proportion of the legume, this reduction being much greater, where the companion grass was cocksfoot rather than perennial ryegrass, and much greater at the higher levels of "Nitro-chalk" application of both grasses. Another important feature is that nitrogenous manuring improved the botanical composition in the direction of a sward consisting of valuable grasses and produced a dense herbage of a "soft" and succulent type.

Effect of Nitrogen on the Percent Dry Matter. In each case, added nitrogenous fertiliser resulted in a reduced percentage of dry matter in the herbage.

This effect was most apparent with the first cut of herbage, where untreated averaged 20.0 per cent. D.M., that which received 2 cwt. "Nitro-chalk" averaged 18.1 per cent. D. M., and that which received 10 cwt. "Nitro-chalk" averaged 16.3 per cent. D. M. The presence of the legume did not, materially affect the dry matter percentage.

Effect of Nitrogen on the Yield of Dry Matter and Crude Protein. The yield of dry matter and crude protein are presented in Table 1.

As might be anticipated nitrogenous top dressings gave increased yields of dry matter, although the increases were by no means proportional to the quantities of nitrogen applied. Although in the majority of cases where nitrogenous fertilizer was applied an increase in yields due to the presence of white clover was apparent, in no case could these increases be regarded as significant. In fact the contribution from white clover without fertilizer nitrogen (under these conditions) over the season in no way approached the increased yields from a single application of 2 cwt. "Nitro-Chalk" per acre. A further point of importance is that a single heavy application of fertilizer showed an effect over all three subsequent cuts, whereas the effect of an application of 2 cwt. per acre was virtually lost after the first cut. The yields of dry matter from the second and third cuts of this treatment were generally lower than those from plots which had received no fertilizer in the first instance, thus supporting the contention that when herbage is cut and removed from a field, further growth depends upon fresh supplies of available nitrogen. In this case the white clover had been sufficiently suppressed to make little material contribution. In the high-nitrogen plots there were sufficient residual nitrogen to show an effect in the second and third cuts, despite a rainfall of 4.67 inches in the interval between applying fertilizer and the first cutting.

The results (Table 1) also indicate that very high yields of crude protein could be obtained by the application of nitrogenous fertilizers. Nitrogen at all rates raised the yield of crude protein in the first cut, the highest being obtained from the heaviest dressing. The figures also demonstrate the relatively low protein content of the grass alone plots, receiving no nitrogen. A noteworthy feature is that the grass-legume mixtures made the highest contribution only in the absence of nitrogen.

TABLE 1—Yields of Dry Matter and Crude Protein—First cut (lb. per acre)

Treatment	*Dry Matter*			*Crude Protein*		
	0N	*2N*	*10N*	*0N*	*2N*	*10N*
S_{24} alone	1,981	3,353	4,670	181	439	767
S_{24} + S_{100} White clover	2,395	3,598	4,963	321	543	830
S_{24} + Wild White clover	2,505	3,542	4,933	271	483	885
S_{37} alone	1,640	3,356	5,522	195	449	1,120
S_{37} + S_{100} White clover	1,797	3,118	5,479	276	452	1,181
S_{37} + Wild White clover	2,062	3,161	5,610	277	516	1,148

TABLE 2—Percentage Crude Protein, CaO and P_2O_5 content in Dry Matter
FIRST CUT

Treatment	*Percent Crude Protein*			*Percent CaO*			*Percent P_2O_5*		
	0N	*2N*	*10N*	*0N*	*2N*	*10N*	*0N*	*2N*	*10N*
S_{24} alone ..	9·18	13·11	* 16·43	1·30	1·16	1·46	1·01	0·84	0·78
S_{24} + S_{100} white clover	†13·40	15·09	* 16·72	1·59	†1·63	1·29	1·02	0·95	*0·70
S_{24} + Wild white clover	10·85	13·63	* 17·12	1·66	†1·51	*1·26	1·00	0·87	*0·86
S_{37} alone ..	11·93	13·39	* 20·29	0·98	1·24	1·18	0·85	0·94	*0·64
S_{37} + S_{100} white clover	15·36	14·50	* 21·57 †	1·53	1·58	1·39	0·97	0·91	*9·68
S_{37} + Wild white clover	13·47	16·33	* 20·47 †	1·43	1·40	1·42	0·93	0·99	*0·66

* Nitrogen effect significantly different at 5 per cent. level.
† Clover effect significantly different at 5 per cent. level.

Effect of Nitrogen on the Composition of Dry Matter. The results of the analyses of the percent crude protein, CaO and P^2O^5content, are shown in Table 2.

Apart from revealing the increase in crude protein content of dry matter following the application of nitrogenous fertilisers, an effect which has been demonstrated on very many occasions (1, 2, 4), these results showed an increase in crude protein due to the presence of white clover. This increase was masked only at the higher level of fertilizer application, and in other cases ranged between 2 and 4.5 per cent. increase—the higher figures resulting in the absence of fertilizer nitrogen.

In every case the presence of white clover resulted in an increase content of Ca 0 in the dry matter, the increase being directly related to the increase in the proportion of clover. "Nitro-Chalk" in itself had no direct influence on the Ca 0 content in the pure grass swards, but through the suppression of clover in the mixed swards it indirectly resulted in a reduced Ca 0 content. This effect was especially great in the plots which received the higher nitrogen dressings. Without clover, the Ca 0 content of the herbage was remarkably constant for both grasses at all levels of fertilizer application.

The presence or absence of clover had little influence on the content of P_2O_5 in the herbage, whereas "Nitro-Chalk" applications significantly reduced the P_2O_5 content. The total weight of P_2O_5 varied only slightly from plot to plot, irrespective of treatment, but with higher yields of dry mtter, particularly from the heavier fertilizer applications, the percentage of P_2O_5 was reduced.

Effect of Nitrogen on the CaO/P_2O_5 Ratio. The influence of nitrogenous fertiliser on the CaO/P_2O_5 ratio is shown in Table 3.

Table 3.—Effect of Nitrogen on the CaO/P_2O_5 ratio

Treatment	*0N*	*2N*	*10N*
S_{24} Alone ..	1·28	1·38	1·87
S_{24}+S_{100} White clover ..	1·55	1·71	1·84
S_{24}+Wild White clover ..	1·66	1·73	1·46
S_{37} Alone ..	1·05	1·31	1·84
S_{37}+S_{100} White clover ..	1·57	1·62	2·04
S_{37}+Wild White clover ..	1·53	1·41	2·15

These interactions considerably altered the ratio of CaO to P_2O_5, which aspect has been regarded as of great consequence in herbage for the dairy cow in particular (3). Both the presence of white clover (through its

effect of increasing the CaO content) and the use of nitrogenous fertilizers (through their effect in leading to a reduction in the P_2O_5 content) resulted in an increase in the CaO : P_2O_5 ratio. The fertilizer applications had by far the greater effect in this respect, and at the 10 cwt. "Nitro-Chalk" level the ratio was as high as 2.15 to 1.

Discussion and Summary

The results of this trial confirm the effects of clover and nitrogenous fertilizer on the quantities and quality of the herbage produced for conservation, as distinct from their effects on a sward which is grazed. Under these conditions, white clover is materially productive only in the absence of nitrogenous fertilizers, and even then the contribution from white clover is not so great as the increase obtained from an application of 2 cwt. "Nitro-Chalk" per acre. Against this, the single moderate applications of fertilizer resulted in reduced yields of herbage in the second and third cuts, due to the suppression of white clover. Heavy dressings of fertilizer nitrogen (10 cwt. "Nitro-Chalk" per acre) resulted in a considerable increase in the yields of herbage and of dry matter, but at the same time the effects of such dressings on the quality of the herbage must be considered.

If crude protein content can be regarded as the true criterion of herbage quality, then quality was improved; but if the CaO : P_2O_5 ratio is of significance, then the reverse is true. Furthermore, the reduction in dry matter resulting from heavy fertilizer applications is of great consequence, particularly where hay has to be made under adverse weather conditions.

These results add support to the suggestion made by Watkin (10) who, doubting the advisability of applying small quantities of nitrogenous fertilizer to the whole of pasture on a particular farm, tentatively recommends the application of heavy quantities of fertilizer to the less leguminous portion of the pasture and no fertilizer nitrogen to the leguminous fields, unless it is desired to reduce the legume content purposely. This argument would appear to apply in the case of grazed or cut swards alike.

References

1. GARDNER, H. W.—The response of permanent grassland to nitrogen and the efficiency of its recovery. *Journ. Agl. Sc.*, 1939. Vol. *29*,364—378.

2. HALLIDAY, D. J. and SYLVESTER, J. B.—Nitrogen for grass, 1950, *Bull. No. 9, Jealott's Hill Res. Station.*

3. HIGNETT, S. L., and HIGNETT, P. G.—The effect of calcium and phosphorus intake on the fertility of cows and heifers. *Vet. Rec.*, 1951, *63*; 603—608.

4. HOLMES, W.—A study of the effect of massive dressings of nitrogenous fertilizer and of the time of application on the yield, chemical and botanical composition of two grass leys. *Journ. Agl. Sc.* 1949. 38 ; 425—436.

5. SEARS, P. D. Soil fertility and pasture growth. *J. Brit. Gr. Soc.*, 1950. 5; 267-280.

6. WALKER, T. W. *et. al.*—The use of fertilizers on herbage cut for conservation. *J. Brit. Gr. Soc.*, 1952. 7 ; 107—130.

7. ibid., 135—150.

8, ibid, 1953, *8* ; 45—70.

9. ibid., 281—299.

10. WATKIN, B. R.—The animal factor and levels of nitrogen, 1954, 9 ; 35—46.

DEPARTMENTAL NOTES

Standard names for Grasses and Legumes Grown in Ceylon

THE NEED for popular names for the grasses that grow in Ceylon was first brought up by Mr. R. H. Spencer Schrader at a meeting of the Central Board of Agriculture held in May, 1953. A sub-committee composed of the following persons was then appointed to prepare a list of popular names in English, Sinhalese and Tamil against the botanical equivalents of all grasses both local and introduced that commonly grow in Ceylon :—

Dr. W. R. C. Paul, Deputy Director of Agriculture (Chairman)

Mr. R. H. Spencer Schrader

Major E. C. de Fonseka

Sir James P. Obeysekera

Gate Mudaliyar N. Wickramaratne

Mr. A. M. Clement Dias

Mr. W. M. Cumaraswamy

Mr. S. Sivapalan

Mr. J. E. Senaratne, Systematic Botanist.

A list was in the first instance prepared by the Pasture Research Committee of the Department of Agriculture of the more common grasses as well as legumes in Ceylon, including those that occur as weeds. This list was then placed before the sub-committee which made certain amendments and added new names of those species for which no common names in Sinhalese and Tamil were known. The amended list was tabled before the meeting of the Board of Agriculture in May, 1954. As no further amendments have been made to the list, it is reproduced below for the benefit of the readers of the *Tropical Agriculturist.*

STANDARD NAMES OF GRASSES

	Botanical Name	*English Name*	*Local Name*
1.	*Alloteropsis cimicina*	Bugseed grass	S. Bu hen tana, T. Unni pillu
2.	*Axonopus affinis*	Narrow-leaf carpet grass	S. Heen pothu tana, T. Sinna sappu pillu
3.	*A. compressus*	Broad-leaf carpet grass	S. Pothu tana, T. Sappu pillu
4.	*Brachiaria brizantha*	Palisade signal-grass	S. Brisantha tana, T. Brisantha pillu
5.	*B. distachya*	Small signal-grass	S. Kuda goma tana, T. Sinna sani pillu
6.	*B. miliiformis*	Large signal-grass	S. Maha goma tana, T. Periya sani pillu
7.	*B. reptans*	Early signal-grass	S. Hin goma tana, T. Ellam sani
8.	*B. purpurascens*	Water grass	S. Diyatana, T. Tanni-pillu
9.	*Cenchrus ciliaris* (*Pennisetum ciliare*)	Fox-tail grass (Buffel grass)	S. Kollukatta tana, T. Kollukattai pillu
10.	*Cymbopogon polyneuros*	Delft grass	S. Delft tana, T. Thiru pillu
11.	*C. confertiflorus*	Mana	S. Mana, T. Mana
12.	*Chloris gayana*	Rhodes grass	S. Rods tana, T. Rodsi pillu
13.	*Chloris inflata* (*C. barbata*)	Purple-top grass	S. Myura tana, T. Mail pillu
14.	*Chrysopogon aciculatus*	Love grass	S. Tuttiri, T. Ottu pillu
15.	*C. montanus*	Kuruvi	S. Kuruvi, T. Kuruvi pillu
16.	*Cynodon dactylon*	Doub grass	S. Ruha, T. Arugam pillu
17.	*Dactylis glomerata*	Cocksfoot	S. Kukul kakul tana, T. Kolikal pillu
18.	*Dactyloctenium aegyptium*	Crowfoot grass	S. Putu tana, T. Kavai pillu
19.	*Digitaria didactyla*	Australian blue grass	S. Nil tana, T. Neela pillu
20.	*D. adscendens* (*D. Marginata*)	Crab grass	S. Guru tana, T. Kera pillu
21.	*D. longiflora*	Creeping grass	S. Vel tana, T. Kodi araku
22.	*Echinochloa colonum*	Wild millet	S. Hin-maratu, T. Sinna kolichudan
23.	*E. frumentacea*	Japanese millet	S. Raja-maratu, T. Periya kolichudan
24.	*Eragrostis tenella*	Feather grass	S. Pihatu tana, T. Siraku pillu
25.	*E. viscosa*	Viscid feather-grass	S. Elena pihatu tana, T. Siraku pani pillu
26.	*E. curvula*	Weeping love-grass	S. Nemi pihatu tana, T. Ododdi
27.	*Eriochloa procera*	Cup grass	S. Koppa tana, T. Karungani pillu

	Botanical Name	English Name	Local Name
28.	*Eleusine indica*	Goose grass	S. Belatana, T. Thippa ragi
29.	*Heteropogon contortus*	Spear grass	S. Estana, T. Panni pillu
30.	*Aristida depressa*	Arrow grass	S. Et. thuttiri, T. Oosi pillu
31.	*Imperaia cylindrica (var. major)*	Illuk	S. Iluk, T. Tharpai pillu
32.	*Ischaemum aristatum (I. ciliare)*	Red-grass	S. Rattana, T. Sem pillu
33.	*I. imbricatum*	Tale red grass	S. Us rattana, T. Katu pillu
34.	*I. timorense*	Stalked red grass	S. Rila-rattana, T. Ilaikampu sempillu
35.	*Lolium perenne*	Perennial ryegrass	S. Dirghayushka rayi tana, T. Pallandu rai pillu
36.	*Melinis minutiflora*	Molasses grass	S. Peni tana, T. Then Pillu
37.	*Panicum antidotale*	Blue panic	S. Krumi sathre, T. Neela ginio pillu
38.	*P. maximum*	Guinea grass	S. Gini-tana, T. Ginio-pillu
39.	*P. repens*	Couch grass	S. Etora, T. Inji pillu
40.	*Paspalum conjugatum*	Sour grass	S. Debe paspalum tana, T. Paspalum puli pillu
41.	*P. dilatatum*	Paspalum	S. Paspalum tana, T. Paspalum pillu
42.	*P. urvillei*	Upright paspalum	S. Us paspalum tana, T. Neetu pillu
43.	*Pennisetum clandestinum*	Kikuyu grass	S. Kikuyu tana, T. Kikuyu pillu
44.	*P. purpureum*	Napier grass	S. Napier tana, T. Napier pillu
45.	*P. purpureum, form Merker's grass*	Merker's grass	S. Merker tana, T. Merker pillu
46.	*Rhynchelytrum repens*	Natal grass	S. Natal tana, T. Natal pillu
47.	*Setaria g eniculata*	Knee bristle-grass	S. Kavalu, T. Thudaippa pillu
48.	*Soporobolus diander*	Drop-seed grass	S. Nisaru tana, T. Asatu pillu
49.	*Themeda tremula*	Dewdrop grass	S. Pinibara tana, T. Pani pillu
50.	*Tripsacum laxum*	Guatemala grass	S. Guatamala tana, T. Guatamala pillu

STANDARD NAMES OF LEGUMES

	Botanical Name	English Name	Local Name
1.	*Alysicarpus vaginalis*	Alyce clover	S. Asvenna, T. Mossel chedi
2.	*Desmodium triflorum*	Tick clover	S. Hin undupiyali, T. Sinna mossel chedi
3.	*D. heterophyllum*	Large tick clover	S. Maha undupiyali, T. Periya mossel chedi
4.	*Indigofera endecaphylla*	Trailing indigo	S. Vel nili, T. Saya avarai
5.	*Medicago sativa*	Lucerne	S. Lusan, T. Lusen
6.	*Prosopis Juliflora*	Algaroba bean	S. Algaroba, T. Algaropa
7.	*Stylosanthes gracilis*	Stylo	S. Stylo, T. Stylo
8.	*S. sundaica*	Townsville lucerne	S. Kvinslanta lusan, T. Kiyunsilan lusen
9.	*Triflorum hybridum*	Alsike clover	S. Alsayik triparnaya, T. Alsayik triparnai
10.	*T. pratense*	Red clover	S. Rathu triparnaya, T. Sivapu triparnai
11.	*T. repens*	White clover	S. Sudu triparnaya, T. Vellai triparnai
12.	*T. subterraneum*	Subterranean clover	S. Polovayata triparnaya, T. Keela triparnai
13.	*Aeschynomene americana*	American joint-vetch	S. Amerika siyambala, T. Amerika puli
14.	*Mimosa invisa*	Creeping mimosa	S. Rata nidikumba, T. Seema totta sinnunki
15.	*Cajanus cajan*	Tur dhal	S. Rata thorai, T. Thavarai

Goats and Sheep Production in Ceylon

IN THE PAST no serious thought appears to have been given to increased goat production and mutton supply, as the demand for meat has been met by the importation of a large number of live goats from South India every month for slaughter purposes.

There are about 550,000 goats and sheep in Ceylon. They constitute an important economic holding to the backward peasantry of the rural areas. Since this industry was handled by the poor man there has been certain amount of neglect by the authorities. The Eastern, Northern, North-Western and Southern provinces afford excellent breeding tracts for goats as jungles of these areas abound with edible foliage. This is an advantage especially in this country where large pasturage cannot be established for fattening of sheep and goats.

The annual requirement of slaughter goats in Ceylon is approximately 155,000 goats. Of this number as many as 75,000 goats are imported from southern India at a cost of four million rupees. The Ministry of Agriculture has now ordered a complete ban on the importation of slaughter goats from India as it is believed that we have enough local goats to meet the demand to a great extent and in order to stimulate increased production. Availability of animals was tested by progressive reduction of the quota of imported goats over the past 18 months and it was found that there was no change in the market price of mutton and the number of animals slaughtered. Other factors which influenced the Ministry to impose the ban are the constant threat of disease like Rinderpest being introduced into Ceylon and large sum of money going out of Ceylon.

With effect from 1st January, 1956, no slaughter goats will be imported into Ceylon. There may be for a while an acute shortage in the meat supply forced by middleman as a reaction to the Government order on importation. It may be noted that the people in this trade are mainly non-nationals. A similar situation arose in 1929 when importation of slaughter cattle from Asian ports was banned in order to eradicate Rinderpest from the Island. At that time some were of opinion that the ban would have serious repurcussions on the meat trade. But conditions returned to normal in such a short time that the prophets who predicted chaos in meat supply were proved false.

The effect of the ban will in the near future reflect on the goat rearing community. This community will soon realize that it is economical to rear goats. But in order to develop a meat industry on an organised basis, it is essential that the middle class should be induced to take to goat breeding. In suggesting this it should not be gathered that the peasant community so long engaged in goat rearing should be smothered. In order to afford protection, peasant breeders should be brought together into a Co-operative Goat Production and Sales Society. This Society will provide facilities like obtaining from Government stud goats, free veterinary service and a reasonable price for their produce. A standard price can be secured by inducing all goat breeders to join the Societies and transacting the sales through them.

M. Z. MAHAMOOTH.

Goat Farming

(Extract from Ceylon Veterinary Reporter, Vol. 3, No. 2, 1955)

OF ALL TYPES of livestock farming goat rearing holds great possibilities in this country as it involves the least expenditure and needs very little expert knowledge. Unlike in dairy farming and poultry keeping, elaborate housing is not necessary while the cost of breeding stock and the construction of a simple shed constitute the only capital expenditure involved. There is also the added attraction that the goat farmer is not engaged for the whole day from early dawn to sunset, as in the case of other stock rearing.

Most parts of Ceylon are suitable for goat rearing and the dry and the semi-dry districts like Hambantota, Wellawaya, Puttalam, Kurunegala, Mankulam, Tamankaduwa, &c., are ideal for the purpose. The scrub jungles and old chenaed land found in these areas provide the best pasturage for goats, as shrubs which cattle reject are relished by goats.

The fact that goats are leaf eating animals may also be taken advantage of for clearing the under brush in lands which are marked out for colonization schemes. By heavy stocking and intensive browsing scrub jungle can be made to disappear in a few years and reduce considerably the initial expenditure of jungle clearing. The lopping of smaller trees to provide fodder after the clearing of under brush could be the next stage of jungle clearing in a planned colonization project.

As stated earlier goat rearing does not require expert knowledge and it is well within the capability of anyone to make it a very profitable concern. In South India from where most of the slaughter goats come into Ceylon, goat rearing is carried on by the poorest and illiterate class of people who have to move their herds over considerable area of scanty vegetation to find the barest

minimum of fodder. In this country where conditions are far more favourable there is no doubt that our villagers could do a better job of it if State aid is given in the form of land on lease and monetary assistance for the purchase of stock.

The convenient size of a herd which one man may look after by himself may be put at 50 adults and followers and the extent of land required for such a unit may be estimated at 50 acres. It is difficult to make a correct assessment of the extent of land required as the carrying capacity would depend on the rate of re-growth of jungle which in turn is dependent on the amount and distribution of rainfall. In these circumstances it is very necessary to have reserve areas of jungle contiguous with these allotments for future expansion of the herd size or to provide browsing if the original allotment of land is unable to contain the herd.

The payment for the lease of a 50 acre allotment which should be a nominal one, may be within the means of a villager but the capital needed for the purchase of stock is certainly beyond his means. It would therefore be necessary for the State to grant him a loan for this specific purpose and to recover it in instalments commencing one and half years after he has settled down on the land. By this time he should have saleable young stock and be in a position, without getting into difficulties, to commence paying back the loan.

As there are no crops to protect it does not appear necessary to fence the land with barbed wire or any kind of fencing material; all that is necessary is to define the allotment by clearing a strip about 6 feet wide right round the allotment. In selecting a site for a scheme of this kind and in marking out allotments provision of watering facilities should be considered. A pond, a tank or a stream with suitable access is all that is needed.

The simplest form of shelter is sufficient to house goats as long as it is dry, free from draught and well ventilated, and the site for it should be an elevated spot from where rain water could easily drain away. All the required timber (unsawn round timber) could be procured from the allotments themselves and except, perhaps, for thatching material and some wire-netting nothing has to be purchased from outside. It will therefore not be necessary to make large grants of money for this purpose.

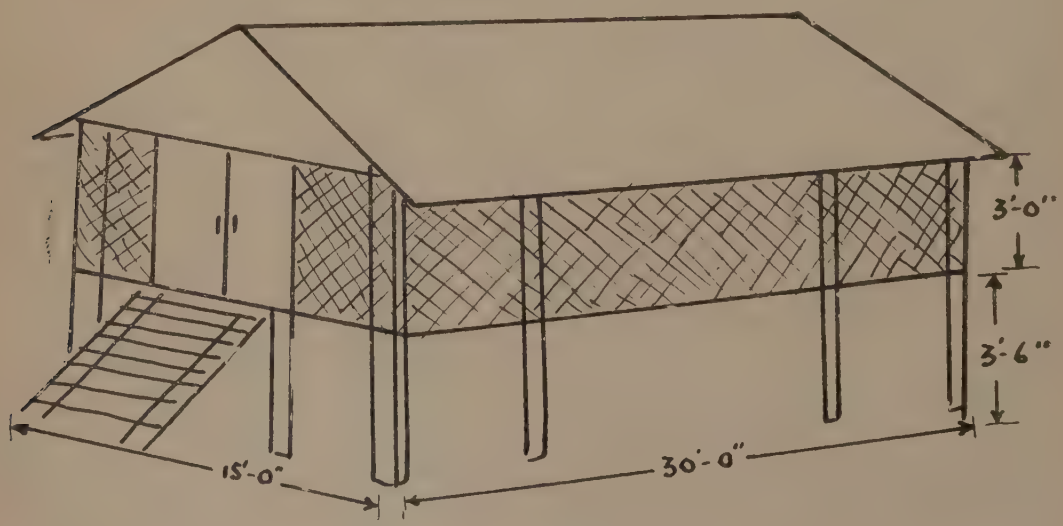

Diagram of a Simple Goat Shed.

Floor space 30′ × 20′. Platform 3½′ high may be supportd on round sticks or arecanut palm reepers. Four sides above platform to be wire-netted. Roof of round timber and cadjan or other suitable material.

A rough estimate for a unit comprising of 50 adult goats and followers is as follows :—

	Rs. c.
Goat Shed built with round timber and platform with sticks ..	500 00
Barbed wire and wire netting ..	150 00
Quarters for herdsman out of wattle and daub ..	750 00
Utensils, (buckets, feeding troughs, lanterns, &c. ..	50 00
Stock—50 She-goats at Rs. 60 each	3,000 00
One Stud goat	150 00
Miscellaneous	100 00
Total	4,700 00

It is my opinion that the State should not undertake the running of these goat farms but every encouragement and assistance should be afforded in the form of land and money to men who are willing to take to this kind of industry. If this principle is agreed to it is suggested that the granting of financial aid should be conditional in that no animals are to be sold without the approval of an officer of this Department who will visit each unit or farm at least once in six months. This will ensure that females will not be sold indiscriminately for slaughter and all females suitable for breeding will be retained either for expanding the herd size or purchased by the State for sale to other breeders. The male progeny, after selecting outstanding specimens for breeding purposes, will normally be permitted to be sold to the butcher.

The Government Veterinary Officer of the area should be requested to make available his services and he should arrange to visit these units periodically and castrate male animals and advise on worming as and when necessary. He may also be authorized to approve the sale of odd animals which in his opinion are poor doers for some reason or another and which are not likely to develop into healthy adults.

W. D. E. PERERA,

BOOK REVIEW

Tropical Poultry Keeping for Beginners—by J. D. Aitken M.A.

"READ NOT TO contradict nor to believe but to weigh and consider". It is in this context that Mr. Aitken's "Tropical Poultry Keeping for Beginners" is reviewed here.

It is reported that "there are 58 breeds of fowls with accepted standards recognised by the British Poultry Club not counting bantams" and Mr. Aitken urges tropical Governments to discourage the importing of bantams, as a bantam cock on free range "can undo the work of years in the district by helping to breed smaller poultry and smaller eggs." The reviewer would go a step further and tender a strong plea for a total ban on the import of all non-utility poultry into countries that are making an honest effort to improve their poultry industry. Non-utility birds are largely imported to Ceylon by "fanciers" many of whom attribute to these breeds virtues that were never claimed even in their country of origin.

To beginners in poultry keeping who decide to import their breeding material from abroad, Mr. Aitken advises, "import direct from a good breeder whose breeding stock has been blood-tested and averages at least 200 eggs a year." It is well to remember in this connection that the heritability of most economic traits in poultry is low, and for the production index itself it is only of the order of 0.05. In fact, all the characters involved in the production index appear to have heritabilities falling below the minimum value at which individual selection is more effective than family selection.

About a third of the book is devoted to various aspects of feeding and Mr. Aitken quotes authority and argument to support the wisdom of his practice of feeding the same mash, containing 20 per cent protein, to chicks, growers and layers alike. Be that as it may, it is becoming increasingly apparent today that the requirements of a poultry ration should be considered more from the standpoint of amino acids rather than from that of the more complex proteins, because it is really the deficiency of any one or more of the amino acids which will limit results. Sometimes, an increase in the protein content of a ration has given decidedly better results, not because the birds needed more total protein, but because by increasing the total protein, deficiencies in the amino acids were rectified. In effect, the same results could have been obtained without increasing total protein, but by using a reasonable variety of feeds in the rations including animal protein feeds, so as to make available all the essential amino acids in necessary quantities.

Nevertheless, "Tropical Poultry Keeping for Beginners" is a book, which to use a well-worn cliche, has filled a "long felt want," and there are many amateur poultry breeders in Ceylon, who will welcome this publication. It deals with all aspects of poultry keeping from systems of rearing to incubation and disease control, and makes several suggestions of value to the beginner. Cold brooders are emphasized, and the use of sex linkage and auto-sexing are also considered. The quality of the photographs is unfortunately poor. Some of the sections are best read in the spirit in which this review is written—"Read not to contradict nor to believe but to weigh and consider". This, however, should not detract from the value of this little publication, which is the first of its kind in Ceylon.

P. M.

CENTRAL BOARD OF AGRICULTURE

PROCEEDINGS OF THE INAUGURAL MEETING OF THE RECONSTITUTED CENTRAL BOARD OF AGRICULTURE HELD AT THE SCHOOL OF AGRICULTURE, PERADENIYA, ON NOVEMBER 21, 1955, AT 2.15 P.M.

Dr. W. R. C. Paul, Acting Director of Agriculture, presided, and the following were present :—Mr. C. A. M. de Silva, Vice-Chairman ; Mr. N. Manicka Idaikkadar, C.C.S., Director of Food Production ; Mr. S. Arumugam, representing the Director of Irrigation ; Mr. Albert Godamunne ; Mr. U. B. Unamboowe, M. P. ; Mr. Clement A. de Silva, Acting Director, Rubber Research Institute ; Mr. S. L. Bandara Dharmakirti ; Mr. R. H. de Mel ; Mr. S. Pathmanathan ; Mr. A. G. Divitotawela ; Mr. M. D. W. R. Saparamadu, representing the Commissioner for Development of Marketing ; Mr. J. M. Sabaratnam ; Mr. D. B. Ellepola ; Senator Lady Adeline Molamure ; Sir James P. Obeyesekera ; Mr. D. C. W. Kannangara, M. P.; Mr. C. F. W. Edirisuriya, M. P.; Mr. Arthur Weerakoon ; Mr. A. M. Clement Dias ; Mr. P. B. Bandaranayake ; Mr. C. T. Van Geyzel ; Mr. R. H. Spencer Schrader ; Mr. G. B. Portsmouth, Acting Director, Tea Research Institute ; Gate Mudaliyar N. Wickremaratne ; Muhandiram T. B. Ekanayake ; Mudaliyar N. M. Abul Cassim Maraikar ; Mr. Anton C. Ponnambalam ; Mr. S. Srinivasan ; Mr. M. B. Samarakoon ; Mr. Ray Wijewardene ; Mr. Emanuel Muttukumaru, Major E. C. de Fonseka ; and Mr. N. P. Wijeratne. C.C.S., Deputy Director of Agriculture (Administration) and Secretary, Central Board of Agriculture.

The following visitors were present by invitation :—

Mr. T. M. Z. Mahamooth, Deputy Director (Animal Husbandry) and Government Veterinary Surgeon ; Mr. A. V. Richards, Acting Assistant Director of Agriculture (Technical) ; Professor Evan A. Hardy ; Mr. C. Chanmugam, Assistant Secretary, Ministry of Agriculture and Food and Mr. T. Concannon.

Letters and telegrams regretting inability to attend the meeting were received from the following :—

The Chairman, Milk Board ; Mr. W. G. Sinclair, Chairman, Planters' Association ; Mr. N. Keerthiratne, M. P. ; the Land Commissioner ; Senator (Mrs.) Clodagh Jayasuriya ; Mr. N. R. Rajavarothiam, M. P.; Mr. W. M. Cumaraswamy ; Director, Coconut Research Institute ; Mr. Kenneth Morford ; Senator E. W. Kannangara ; Mudaliyar S. Armstrong ; the Director of Land Development ; Elapata Dissawe ; Mr. K. W. Devanayagam ; Mr. Singleton Salmon, M. P.; the Director of Rural Development ; Mr. V. G. W. Ratnayake, M. P. ; the Commissioner for Co-operative Development and Registrar of Co-operative Societies.

I—Confirmation of the Minutes of the Last Meeting

The minutes of the previous meeting of the Central Board of Agriculture were unanimously confirmed.

II—Address by the Chairman

"Permanent Secretary and Members of the Board—it is a great pleasure as well as a privilege to me to extend a warm welcome to all members of the reconstituted Central Board of Agriculture which holds its inaugural meeting today. I see before me many old faces of those not only of the last but also of several previous Boards. Those of you who are present here for the first time take their seats as experienced and accredited agriculturists who will I am sure infuse fresh blood by bringing a new outlook in the approach to the problems that will engage the attention of the Board. I must on your behalf express to the Permanent Secretary how much we appreciate his presence here today.

The new Board is appointed by the Honourable the Minister for Agriculture and Food for a period of three years from this month and it is now reduced from a total membership of 83 to 60 as it was felt that the former Board was too large and unwieldy. The Board is the premier unofficial advisory body on agriculture to the Minister and although it has no executive function it can serve a very useful purpose and also make a real contribution to solving the agricultural problems of the country by its wise counsel and advice.

In the past, the Board has functioned generally by passing resolutions which were forwarded to the Ministry. May I suggest in addition to this purpose, that members should relate their observations and experiences in particular subjects of agriculture and pass on such information of practical value which will be of benefit not only to the Department of Agriculture but to several other Departments that are associated with the development of agriculture in this country? I do hope that the discussions of the Board will be maintained at a high level so that it will be held with esteem and regard by the public for the quality of its deliberations and the sound practical measures that it tenders to the Ministry.

May I appeal to members of the Board to be as brief as possible in their observations in order that all those who desire to make a useful contribution to a subject under discussion may be given the opportunity to do so? In order that every member may be able to hear speakers clearly I shall be grateful if each speaker comes up to the rostrum to address the Board. As I should set an example in brevity I will conclude my remarks by thanking all those for the trouble they have taken to attend this meeting and to wish the Board all success in its efforts for the period assigned to it".

III—Election of a Vice-Chairman

Mr. R. H. Spencer Schrader proposed the name of Mr. S. Pathmanathan as Vice-Chairman of the Board but Mr. Pathmanathan declined.

Mr. C. F. W. Edirisuriya, M. P., proposed the name of Mr. C. A. M. de Silva as Vice-Chairman and Mr. U. B. Unamboowe, M. P., seconded.

There being no other names, Mr. C. A. M. de Silva was duly elected Vice-Chairman. Mr. de Silva thanked the Board for his re-election and occupied the Vice-Chairman's seat.

IV—Adoption of the Rules

Mr. S. L. Bandara Dharmakirti inquired what the Committees referred to under Rule IX were.

The Chairman said that the proposed Committees were,—

(1) Paddy Committee
(2) Minor Products Committee
(3) Livestock Committee
(4) Education Committee.

Mr. D. B. Ellepola pointed out that the last Board had appointed various Committees and that some of them met that morning though strictly speaking it was not quite in order as they were Committees appointed by the out-going Board. Since members had come from various parts of the Island to attend those meetings, they were held, and Mr. Ellepola inquired whether they should consider themselves as having been appointed to the Committees as from November 11, 1955?

Mr. C. A. M. de Silva, Vice-Chairman, replied that that procedure would not be correct since some of those members might not be in the new Board.

The Chairman stated that since these Committees had already met, the work they had done would not be ignored altogether, and that as there was no finality in the discussions, there is no reason why these Committees cannot meet again. He added that there was no necessity to quibble over the matter as the newly constituted Board had already met.

Chairman—" The Secretary suggests that it will be an advantage if the Convenors of these Committees are officers of the Department of Agriculture. If you agree to this, I shall ask you to nominate members to serve on these different Committees. Some of the

members who served on those Committees of the previous Board are not members of the present Board but there is no objection to co-opting them."

Mr. Anton Ponnampalam suggested and it was agreed by the Chairman and members of the Board that members should write down in a slip of paper the names of the Committees they would like to serve on so that much time could be saved in the election of members to the different Committees.

Mr. Anton Ponnampalam also inquired from the Chair whether at the request of absentee members, those present could submit their names for certain committees.

The Chairman had no objection to this being done.

The procedure suggested by Mr. Ponnampalam was adopted and the following members were elected to the Committees shown below :—

SUB-COMMITTEES OF THE CENTRAL BOARD OF AGRICULTURE

A. *Paddy Sub-Committee—Convenor—Botanist and S. A. R. O.*

Director of Food Production
Mudaliyar N. Wickremaratne
Mr. Albert Godamune
Mr. C. F. W. Edirisuriya
Mr. U. B. Unamboowe
Mr. A. M. Clement Dias
Commissioner for Development of Marketing
Mudaliyar N. M. Abul Cassim Maraikar
Mr. Anton Ponnampalam
Mr. Abraham Abeywardene
M. S. Srinivasan
Mr. D. C. W. Kannangara
Mr. D. B. Ellepola
Sir James P. Obeyesekera
Mr. Arthur Weerakoon
Mr. J. M. Sabaratnam
Mr. M. B. Samarakoon
Muhandiram T. B. Ekanayake.

B. *Animal Husbandry Sub-Committee—Convenor—Deputy Director, Animal Husbandry*

Mr. C. A. M. de Silva
Major E. C. de Fonseka
Mr. W. M. Cumaraswamy
Mr. R. H. Spencer Schrader
Mr. A. M. Clement Dias
Sir James P. Obeyesekera
Mr. Arthur Weerakoon
Mr. C. T. Van Geyzel
Mudaliyar Abul Cassim Maraikar
Mr. R. H. de Mel
Mr. Anton Ponnampalam.

C. *Minor Products Sub-Committee—Convenor—Chief Research Officer*

Mr. M. B. Samarakoon
Commissioner for Development of Marketing
Mr. S. Pathmanathan
Mr. Emanuel Muthukumaru
Mr. D. B. Ellepola
Mr. A. G. Divitotawela
Mr. U. B. Unamboowe
Major E. C. de Fonseka.

D. *Agricultural Education—Convenor—Principal, School of Agriculture, Peradeniya*

Senator Lady Adeline Molamure
Mr. S. Srinivasan
Mr. D. C. W. Kannangara
Mr. Ray Wijewardene
Mr. D. B. Ellepola
Mr. J. M. Sabaratnam
Mr. S. Pathmanathan
Mr. P. B. Bandaranayake
Mr. R. H. de Mel.

Mr. S. Pathmanathan suggested the name of Mr. C. E. P. Jayasuriya, Director of Commerce, as a member of the Minor Products

Sub-Committee and said that his knowledge and experience would be very valuable to the discussions.

The Chairman replied that it would not be correct to appoint him a member of a Sub-Committee as he was not a member of the Board.

Mr. N. Manicka Idaikkadar, Director of Food Production, inquired why the District Agricultural Committees of Galle and Kurunegala had not been represented on the newly constituted Board of Agriculture and there were two representatives from the Badulla District Agricultural Committee.

The Secretary Mr. N. P. Wijeratne, explained that originally Anuradhapura and Badulla were given two members each in view of their size. The two members at Anuradhapura were reduced to one and Polonnaruwa, a new district, was given one. Similarly Badulla would also continue with two members until the new district units were formed. The difficulty with Galle and Kurunegala was that those District Agricultural Committees have not met for some time and until they recommend a nominee the two places will not be filled.

Mr. C. F. W. Edirisuriya inquired whether it was not possible to arrange for meetings of the different Sub-Committees to be held in Colombo as he and other Members of Parliament who were members would find it more convenient.

Chairman—" May I suggest that you take up the matter with each Convenor of the Committees so that if a majority of the members prefer Colombo, it could be arranged ? "

At this stage the Chairman inquired whether the members were prepared to adopt the rules as the Committees have been appointed.

The Rules of the Board were then put to the House and unanimously adopted.

V—Matters arising from the Minutes of previous Meetings

Chairman—" Mudaliyar Armstrong moved a resolution at the eighth meeting of the Central Board of Agriculture that in view of the large extent of paddy lands that are situated bordering the lagoons of the Batticaloa District being submerged and damaged by floods annually, suitable openings of sand bars should be effected during the South-East monsoon. This matter was referred to the Government Agent, Batticaloa, and the Government Agent, Batticaloa District, has replied to say that at the meeting of the District Agricultural Committee held at the Kachcheri on October 1, 1955, it was decided to refer this matter to the Gal Oya Valley Flood Committee for investigation and suitable action. "

The other was a request made by Mr. Ray Wijewardena to the Department of Meteorology for a long-range weather forecast and this matter was referred to the Director of Meteorology and this is the reply we have received—

" Reference your letter dated September 12, 1955, and the annexed page from ' Farm Journal ', returned herewith.

Dr. Krick is presumably a private meteorologist, and I would not comment on the validity of his forecasts without a knowledge of the methods employed. But I have a booklet before me, also produced by a private meteorologist, giving a forecast, month by month, for various parts of the United States for the whole of the ensuing year, *not* just two months in advance. This latter is based on planetary positions, as is the yearly weather forecast appearing in our own astrological almanacs. Such forecasts have no scientific basis. Most other attempts at long-range forecasting by private individuals are based on empirical rules on slendor or no scientific basis.

2. After years of research, the U. S. Weather Bureau attempts, on an experimental basis, a monthly forecast, while the U. K. Meteorological Service is even more cautious, giving only a general outlook for the ensuing 4-6 days. The official policy of the U. S. Weather Bureau is to avoid controversies by expressing opinions on the work of private meteorologists, unless their activities are contrary to the public interest.

3. The problem of long-range weather forecasting in Ceylon, as I explained at the eighth meeting of the Central Board of Agriculture, needs investigation by the

application of modern techniques to Ceylon conditions. Attempts by private meteorologists in the U. S. are of no significance to us.

There was also a resolution by Mudaliyar Armstrong that in view of the importance of levelling paddy fields in order to increase yields, Government should purchase earth moving tractors and scrapers in order that such works may be carried out on a hire-basis system. This matter was taken up with the Director of Food Production and a formal reply is awaited."

Mr. D. B. Ellepola—"If you are dealing with matters arising from the minutes, I would like to inquire whether the figures given in page 11 refer to production figures or import figures of rice, I think they should be local production figures."

Chairman—"That is a mistake. They should be local production figures."

Referring to a proposal appearing in the minutes of the last meeting of the Central Board that a request should be made to the Standing Committee of Land Development to re-map the patana lands in Maha-Palata Korale of Udukinda Division for Village Expansion and allocate twenty-five per cent. of it for village forests before the area is given out to the landless and that the area to be planned as village forests should be re-surveyed with the assistance of a Soil Conservationist and a Forester and handed over to the Forest Department to be planted in trees for the use of the local population as fuel, Mr. D. B. Ellepola spoke thus: "I know that in the Uva province the entirety of the Uda Kinda and Yati Kinda areas have been completely block-surveyed and have already been mapped out. In all these areas mapping out has already been done and once the mapping out proposals were approved there is no authority for anyone to alter them. Therefore I feel that we do not need to have another survey as such, and that we proceed on the information that we have already got".

Mr. N. P. Wijeyeratne, Secretary—"The Soil Conservation Officer says that the mapping out has not been done on any technical basis and that this should be brought to the notice of the authorities so that the area may be re-mapped."

Mr. D. B. Ellepola—"At the time these lands were originally mapped out, certain forest lands were reserved, so that I do not think that we should tread on that ground again. We have already got that wealth of information and the Soil Conservation Officer could proceed on that basis."

Chairman—"The Soil Conservation Officer's point is that the whole work has to be re-considered especially in the Uva area, which is liable to erosion. He therefore desires to re-examine the problem in the light of information that is now available with a view to the conservation of both soil and moisture. I agree that if it has been laid down by Ordinance that once an area has been mapped out no change can be effected, we cannot do anything in the matter except to inform the Land Commissioner of the position and if it is possible, fresh mapping out proposals in the light of any information the Soil Conservation Officer wishes to bring out can be made."

Mr. D. B. Ellepola—"May I suggest that a diagram be prepared with reservations for village forests, pasture area, &c., in the first instance?"

Chairman—"Yes, but unfortunately in these hilly areas lands that should not be alienated have been cleared for growing food crops and the Soil Conservation Officer is anxious that this should not happen again."

VI—A Message from the Acting Permanent Secretary

Mr. W. J. A. Van Langenberg—"Mr. Chairman, Ladies and Gentlemen—I am a temporary Permanent Secretary who has come here in the absence of the Permanent Secretary. I have been asked by the Honourable Minister to tell you that he is exceedingly sorry that he is unable to be present owing to another appointment which he is unable to cancel. He would have been certainly very happy to be present at this inaugural meeting of the Board but for this appointment and has asked me to convey his good wishes and hopes for a very happy future to the Board. Thank you."

At this stage Muhandiram T. B. Ekanayake requested the Chairman to permit him to

bring up before the Board a very urgent matter and the Chairman allowed him to speak.

Muhandiram Ekanayake speaking in Sinhalese said that there were over 10,000 acres of paddy land in the Polonnaruwa area on the verge of a disastrous failure due to want of water. He added that out of this acreage about 5,000 acres were to be transplanted and that all their efforts would be in vain if the Irrigation Department is unable to find the water required. He also said that if these 10,000 acres of paddy failed, a large number of people in the area whose main occupation was paddy cultivation would have to starve. At this stage Mr. N. P. Wijeratne, Secretary, spoke in Sinhalese and explained to Muhandiram Ekanayake that Government had some time back ordered that the area referred to by Muhandiram Ekanayake should not be cultivated in *Yala*, but the people in the area had forced the Government to issue water. Therefore the people in the area had acted against the advice of the Government. The actual position at present was that if the available water was issued, there would not be sufficient water to go round. He, however, added that if it was the intention of Muhandiram Ekanayake that the Board should write to Government on this matter he was prepared to do so but the Irrigation Department had stated that there was no water to be issued.

Mr. Anton Ponnampalam pointed out that that was a matter to be brought up before the District Agriculture Committee and that if it was a problem affecting the whole Island there was no harm in bringing it up before the Central Board.

Chairman—"I gave him permission to bring this up before the Board as I was told that this is a matter of urgency."

Mr. Anton Ponnampalam—"If the Chair had given permission, I withdraw my remarks."

Mr. Wijeyeratne, Secretary, explained further in Sinhalese that although that matter had been brought up before the Board, the Board could not do anything except to inform the authorities.

Mr. C. F. W. Edirisuriya, M. P.—also speaking in Sinhalese said that Government had permitted the people in the area to do *Yala* cultivation because there was sufficient water. Now if the people were unable to proceed with their cultivation operations owing to lack of water, it is for the Government to grant them some relief on a matter of principle either by relief work or "Tattunaru". He added that the poor "Goiyas" in the area had no other means of livelihood except paddy cultivation and it was for the Government to step in when they were in a difficulty.

Mr. Albert Godamune—"He has brought up a definite grievance before this Board and I feel that the Board should take it up."

Chairman—"This is not a definite resolution that has been brought up. If he did not raise it as a matter of great urgency, I would not have allowed it. I do not think this Board should entertained matters of this nature which should in the first instance be taken up at the Local District Agricultural Committee."

Mr. Albert Godamune—"Now, since you have given him permission to bring up this question as a matter of urgency as a week's delay might ruin over 5,000 acres of paddy, there is no reason why this Board should not communicate with the authorities and see what can be done."

Mr. N. P. Wijeyeratne, Secretary—"This matter has already been looked into by the authorities. The A. G. A. was against any *Yala* cultivation being done but he was overridden on this matter. Therefore the best advice that this Board can give the Minister is not to allow *Yala* cultivation in this area."

Chairman—"Before we go on to the next item, I would like to state that Lady Molamure has expressed a desire to serve on the Agricultural Education Sub-Committee, and Major Fonseka on the Minor Products Sub-Committee."

(At this stage there was a tea interval of 10 minutes.)

VII—Resolutions to be Moved by Gate Mudaliyar N. Wickremaratne

(i) That natural pastures and grazing grounds in the country should be preserved for the use of country cattle

and therefore should not be alienated for any other purposes.

(ii) That immediate steps should be taken in consultation with the Government Agent, Polonnaruwa, to preserve these natural pastures and grazing lands for the pattiers of Tamankaduwa cattle —neat cattle and buffaloes on either banks of the Mahaweliganga from its confluence with the Ambanganga to the Sea Board. And organise these pattiers into proper cattle farms without any restriction of forest and these natural pastures and thus prevent the erosion of fertile soil.

Chairman—" I would be grateful if Gate Mudaliyar Wickremaratne would be as brief as possible. "

Gate Mudaliyar Wickremaratne—" Mr. Chairman, Ladies and Gentlemen—In the first instance I like to express my appreciation of the presence of the Permanent Secretary to the Ministry of Agriculture and Food. We have for sometime now felt that an official of the Ministry should be present at the deliberations of this Board. Today I am pleased to see Mr. Van Langenberg, whom I know, present with us. Similarly, we have with us at this meeting the Acting Director of Agriculture and I appreciate his conduct of the business at this meeting and I wish him success.

Sir, my motion is a very simple one. It is based on the cattle wealth of the country —known in Sinhalese as 'Gawa Sampath'. In this country if we cannot grow sufficient rice for our needs how can the cattle find sufficient pasture for themselves. At the last meeting of the Board Major Fonseka brought up a resolution about patana fires and I appreciate the stand taken by the Forest Department and the Soil Conservation Officer. I think Major Fonseka agreed at that meeting that pasture was required for the vast cattle population. It was also suggested that pasture lands for grazing should be demarcated. Now the question is who is going to do that? Our Ministries are so divided that we have to do agriculture without lands and we have land without agriculture. Now who is going to do this work of demarcating and establishing pasture grounds? I will answer that question. If Government is taking steps to preserve pasture I suggest that the Deputy Director of Animal Husbandry, Dr. Mahamooth who has done very good work from the beginning of the Department should do it with the Soil Conservation Officer. The Forest Officer and the Government Agent of the District should be made to demarcate all available pasture lands for cattle. I would also suggest that where there is no pasture land available they must find some land for establishing pasture." Gate Mudaliyar Wickremaratne said that some years back he had of places upcountry where several pastures and grazing grounds had been set aside for country cattle. One such place was the "Diyanila" (means water and green grass) between Ragalla and Harasbadde. This was an ideal pasture for Wallapone cattle. But later on when estates were established all those areas disappeared. He emphatically urged that at least a quarter of that area should be set apart for pasture. "In 1902 there was a cattle krall established here and after that the Ceylon Agricultural Society opened up the Herasbedde Farm with Government aid. But now those farms are no longer in existence. Kotmale people take their cattle through Nuwara Eliya to Bopatalawa because all the land has been taken over by tea planters and others. Similarly areas like Uda Bulathgama and Udukinda are affected. Pattipola was in the good old days the biggest grazing ground for cattle and that it is how it has derived its name Pattipola which means cattle farm. Now what has happened is that Government has taken over this area for the good of the country and introduced European breeds of cattle. As a result, our local cattle have no place to go to. Similarly our villagers' cattle also required pasture and grazing grounds. We require pasture grounds also in Hambantota, Mannar, Gampaha, Kalutara and other areas. In these area land for pasture grounds should be demarcated and it should not be allowed to be utilized for other purposes as in the wet country where such land has been taken over for planting with tea and rubber. I hope my proposal that Government should take action to demarcate and set apart pasture lands will meet with your support."

Chairman—"I am very grateful to the Gate Mudaliyar for the very concise speech he made and I hope other members will follow in the same way."

Mr. C. W. F. Edirisuriya, M. P.—"I come from a paddy growing area where from my childhood and even during the Colonial days it was the practice to set apart some pasture lands for the cattle. But I find that ever since we gained independence with all our various Ministries and with all the mechanization we have adopted we are not moving in the right direction. Today the authorities say that paddy cultivation should be mechanized and that the neat cattle should be sent to the butcher. From my experience I know that these country cattle not only help in our cultivation operations but they add a lot of manure to the paddy fields. We have been told that for the last 6 or 8 years that the various G. AA. and Ministers have taken steps to demarcate pasture lands and that there is a dearth of land. If 400,000 acres can be set apart for the Yala Game Sanctuary, I don't see why we should not be able to find some land for pasture. Today we always get complaints that several acres of cultivated land have been damaged by cattle. If we have sufficient pasture lands this difficulty would not arise. I know that even with 4 or 5 strands of barbed wire cattle have broken into cultivated land and valuable crops have been devastated. I therefore strongly support Gate Mudaliyar Wickremaratne's motion and have pleasure in seconding it. I would also with the permission of the Mudaliyar suggest an amendment that the old system of cattle vouchers be re-introduced."

Mr. R. H. Spencer Schrader—"While I agree with the views put forward by Gate Mudaliyar Wickremaratne there will be great difficulty in demarcating the land for pasture without some authority to look after them. Immediately the pasture land is demarcated every villager will drive in his cattle and within a very short time you will have the land but no pasture and soil erosion will take place and there will be a tremendous lot of difficulty in re-establishing pasture on that land. There must be some means by which over-crowding has to be stopped. I think a Committee should go into this question. I can claim over 40 years of experience in pastures and I can assure you that one of the most difficult jobs on earth is to establish pasture where there has been no pasture and if there is any over-crowding, your pastures will be ruined. I think the Chairman has also a lot of experience in this matter and would agree to look into the important question of how over-crowding should be stopped and who will look after these pasture lands. I am not against Gate Mudaliyar's resolution but what I wish to point out is that there is great danger in establishing pasture lands without anybody to look after them."

Chairman—"Would Mr. Mahamooth like to make any comments?"

Mr. T. M. Z. Mahamooth, Deputy Director, Animal Husbandry and Government Veterinary Surgeon—"Gate Mudaliyar Wickremaratne's resolution is a very important one. This subject has been discussed time and again for the past several years. I think a number of Sub Committees have met and discussed this subject but we are still in the same position. In this connection I might say that as a result of a direction from the Honourable the Minister of Agriculture and Food a Sub Committee was appointed recently consisting of the Members of Parliament for the Eastern Province with the Deputy Director of Animal Husbandry, that is myself, as Convenor, to go into this question of finding pasture lands in the Eastern Province—that is in the Gal Oya Valley. A certain area has been demarcated but at the same time we are finding ways and means of controlling the pasture as has already been pointed out by Mr. Schrader. There are great advantages in controlling over-grazing in addition to demarcating the pasture lands, because even various diseases can spread if the pasture is not properly controlled. First of all these areas have to be demarcated and fenced and paddocked and then improved pasture established and every paddock will have to be grazed under controlled conditions.

The report of that Sub Committee is not complete as yet and we hope to complete it in a few weeks time. The main thing is to

control pasture and there must be somebody in authority to look after the land. I quite agree with the resolution of Gate Mudaliyar Wickremaratne".

Mr. S. Pathmanathan—"We suggest that there should be valuable land preserved for the purpose of feeding uneconomic cattle in the country. There are today, if you go round the Island, hundreds of thousands. They are a great liability to the owners from the point of view of milk and meat. The average villager has been used to maintaining this type of animal but most of these cattle, except those used for agricultural purposes, are a burden on them. They sneak into our paddy fields or young coconut plantations. But when you analyse it, should we preserve these uneconomic animals or the valuable land. The population is increasing annually and that itself is a problem. Should we devote this valuable land for the purpose of feeding uneconomic animals?"

Mr. Anton C. Ponnampalam suggested an amendment to the resolution of Gate Mudaliyar Wickremaratne that the words "country cattle" to be substituted by the word "cattle".

Gate Mudaliyar Wickremaratne—"I used the words 'country cattle' because dairy owners can afford to look after their cattle. But, however I have no objection to the amendment.

I would like to reply to Mr. Schrader and Mr. Pathmanathan. Mr. Schrader has been my opponent here for years but today I find he has changed his views. (Laughter). I only suggested that the land should first be demarcated as pointed out by Dr. Mahamoth. After the land is demarcated we can see to other things like establishing and controlling pasture. Any way I do not take Mr. Schrader's remarks seriously.

I am sorry to say that Mr. Pathmanathan is interested only in coconuts, rubber and other products but he is not interested in cattle. I never used the word 'uneconomic' cattle in my resolution or in my remarks. Uneconomic cattle can be despatched to the butcher. Even if there are uneconomic cattle, we could castrate the bulls and use them for ploughing or send them to the butcher. I am very sorry that a man of Mr. Pathmanathan's experience has taken that view. Every land is valuable whether it is for food production or for cattle. You cannot grow paddy without cattle. This mechanization will have to go out of the map. I tell you, that 50 years hence Batticaloa or Hambantota or any other place where they use mechanized cultivation will turn into desert. You know what has happened to Tennesy Valley by using heavy machinery. Gal Oya will meet with the same fate. That land has now lost its fertility because of the damage done by these heavy machinery. The other question is from where are we going to get our milk? We have viewed this question from all angles and I have brought up this resolution. Since my resolution is proposed and seconded, the Ministry can take any action it wants."

Chairman—"The resolution has been moved and seconded. I should like to say that there are about a million head of cattle in this country and if you go by stocking rates in other countries where pastures are highly developed, we may need about four million acres of pasture for this country. I am sure that Mudaliyar Wickremaratne will not want this scheme to be dropped because of difficulties of this nature, but I do not know how we can set apart for pasture such a large acreage out of the 3½ million acres of land that is left for development. As Mr. Schrader has said pastures have to be looked after and if they are to be a success, rotational grazing has to be practised otherwise the pastures would degenerate into very inferior paddocks."

Mr. C. F. W. Edirisuriya, M. P.—"Although 4 million acres would be required for the whole Island, I think we should make a start with places like Hambantota where you get about a thousand acres of waste land. What I suggest is a gradual process of alienating the available waste lands for purposes of pasture."

Chairman—"Mudaliyar Wickremaratne is anxious that this resolution be given serious consideration. We have an Animal Husbandry Committee which can take up questions of this nature. May I suggest that

if you accept this resolution that it be referred to the Animal Husbandry Committee for details? We may accept the principle but unless we have details I do not think it will be possible to implement the proposal."

Gate Mudaliyar Wickremaratne—"If the Committee wants details, I am prepared to give it but I do not want this to be treated as a resolution."

Chairman—"I am happy that Mudaliyar does not want this treated as a resolution. This Board should not merely pass resolutions. A discussion is much better where members could express their views.

May I therefore suggest that this matter be considered in detail by the Animal Husbandry Committee and in the meantime Mudaliyar Wickremaratne will prepare a memorandum which will provide the data for discussion."

Mr. Anton C. Ponnampalam—"If they tell us on what date they are going to discuss this, other members who are prepared to speak could also take part."

This was agreed to by the Chairman.

Resolution moved by Gate Mudaliyar N. Wickremaratne—

> "(ii) That immediate steps should be taken in consultation with the Government Agent, Polonnaruwa, to preserve these natural pastures and grazing lands for the pattiers of Thamankaduwa cattle—Neat cattle and buffaloes on either banks of the Mahaweliganga from its confluence with the Ambanganga to the Sea Board. And organise these pattiers into proper cattle farms without any restriction of forest and these natural pastures and thus prevent the erosion of fertile soil."

Gate Mudaliyar Wickremaratne—"The best pastures in the Island are found at Bopatalawa, Pattipola and Ambawela and a foreigner who has been got down by the Department of Agriculture is utilising all this area to improve foreign breeds."

Chairman—"I do not think it is fair to make any aspersions of that nature to a foreign gentleman."

Gate Mudaliyar Wickremaratne—"There are natural pasture grasses around 'villus'. They are often found in the jungle. These grasses grow very well by the 'villus' and people send their cattle to find these natural pastures. Some of this land is also used to grow tobacco. Batticaloa people come periodically and grow their tobacco in these places. Sometimes they bring their cattle and allow them to remain. Among them you get the Thamankaduwa cattle and other cattle. Then again at Polonnaruwa and Minneriya, owing to the Development Scheme, the cattle have no place to graze on. But somehow the cattle now find their way to the bank of the river for grazing and now there is a suggestion that these banks should be cleared and used for sugarcane cultivation, or for food crops. Here we want to starve our cattle and grow sugarcane. In Gal Oya there are thousands of acres of land. Why not grow sugarcane there? When these river banks are used for cultivation purposes what happens is the land begins to erode and it is washed down to the river. Therefore I would like Dr. Mahamooth to draw up a definite plan with his assistants in the Animal Husbandry Department for the Thamankaduwa cattle so that the villagers would be able to look after their cattle."

Chairman—"The plan has already been drawn up and the Milk Board has taken steps to implement it."

Mudaliyar Wickremaratne—"I hope they will not cut down the jungle. Because of these jungle clearings even our elephants will be extinct after some time. Already in China Bay a herd of elephants are roaming all over. I appeal to the members to go there and see it for themselves. I went there and saw it myself."

Major Fonseka—"As the Chairman mentioned about the Milk Board, I would like to say that a Milk Collection Centre is to be established at Welikande. There is not the slightest doubt that this is the finest pasture ground in the whole of South East Asia. You will be surprised to hear that only recently members of the Milk Board went there to find over 2,000 head of cattle and we are depending on this project for very many milk schemes that we have got at the back

of our minds. Gate Mudaliyar Wickremaratne visualises a destruction of forests in that part of the country. I can assure the Mudaliyar that nothing of that sort is likely to take place. He also suggested the organisation of pattiyas. I can tell him that the General Manager of Farms has already handed over twenty-two young Tharparkar bulls to the owners of cattle in that area."

Chairman—"May I therefore suggest that you refer this item to the Milk Board for its further consideration? As I said earlier, action is already being taken and this important resolution from Gate Mudaliyar will strengthen the hands of the Board".

Chairman—"May I ask that items 3 and 4 be taken up at the next meeting?"

This was agreed to and the meeting terminated at 4.30 p.m.

N. P. WIJEYERATNE,
Secretary,
Central Board of Agriculture.

January 3, 1956.

METEOROLOGICAL REPORT

October-December, 1955

	October									November			
	Temperature				Humidity		Rainfall			Temperature			
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Min. Temps.)	Total	Offset	No. of days	Mean Maximum	Offset	Mean Minimum	Offset
Anuradhapura	87·0	—2·0	73·6	+0·1	75	93	5·73	—3·99	14	85·9	+0·1	70·8	—0·6
Badulla ..	83·3	+0·5	65·3	—0·2	70	95	4·48	—4·41	15	80·5	+1·3	64·6	—0·8
Batticaloa ..	87·2	+0·2	75·8	+0·5	74	88	11·29	+4·10	15	85·1	+9·9	73·8	—0·4
Colombo ..	84·5	—0·4	75·5	+0·7	76	84	16·11	+2·40	21	84·0	—1·3	72·9	—0·4
Diyatalawa ..	78·3	+2·0	59·9	—0·7	73	89	12·76	+3·58	17	76·6	+2·4	59·0	—0·8
Galle ..	82·8	—0·2	76·6	+1·2	80	86	12·19	—0·14	18	82·3	—1·3	74·2	0
Hambantota ..	84·3	—1·8	76·2	+0·9	75	86	1·97	—2·79	8	85·6	+0·2	74·2	+0·2
Jaffna ..	85·5	—0·2	78·2	+0·6	80	86	9·61	+0·41	9	84·0	—0·1	75·3	+0·5
Kandy ..	82·1	—3·4	67·7	—0·3	70	87	5·57	+6·04	15	81·8	—1·1	66·8	—0·7
Kankesanturai	87·1	—	77·0	—	77	91	8·51	—1·11	12	83·6	—	74 6	—
Kurunegala ..	85·8	—1·4	73·9	+0·7	76	90	17·20	+2·34	15	85·7	—1·2	71·4	—0·4
Mannar ..	87·0	+0·1	79·0	+1·7	78	86	3·81	—2·77	7	84·4	—0·2	76·3	+0·7
Nuwara Eliya	68·1	+0·5	53·6	+1·5	79	85	6·28	—3·48	14	67·0	—0·8	52·4	+1·3
Puttalam ..	86·9	+0·7	76·9	+1·3	72	84	5·69	+1·74	10	85·4	—0·3	73·4	+0·3
Ratmalana ..	86·2	—	75·9	—	73	86	15·51	+2·31	21	85·6	—	73·6	—
Ratnapura ..	87·1	0	72·8	0	73	93	18·72	+0·71	24	87·3	—0·5	72·3	+0·1
Talawakele ..	71·1	—	56·7	—	83	97	6·48	—	15	70·4	—	56·3	—
Trincomalee ..	90·4	+2·5	76·7	+1·1	68	82	2·28	—7·27	13	85·0	+1·5	74·5	—0·3

	November—*contd.*					December								
	Humidity		Rainfall			Temperature				Humidity		Rainfall		
	Day	Night (from Min. Temps.)	Total	Offset	Number of days	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Min. Temps.)	Total	Offset	No. of days
Anuradhapura ..	76	95	6·64	—4·03	18	83·2	0	68·8	—1·3	75	95	2·56	—4·96	11
Badulla ..	73	94	5·46	—4·49	11	75·6	—1·0	63·5	—1·0	82	94	5·40	—5·83	20
Batticaloa ..	75	90	6·45	—7·41	14	81·2	—0·8	73·4	—0·2	76	86	6·37	—10·62	16
Colombo ..	74	88	12·23	—0·86	19	85·0	—0·5	71·1	—1·3	66	83	2·52	—3·09	6
Diyatalawa ..	76	91	9·10	—1·32	18	71·3	—0·8	58·0	—0·7	83	94	2·91	—5·16	22
Galle ..	79	88	19·11	+7·10	22	83·2	—0·4	72·5	—0·9	78	90	3·85	—3·97	10
Hambantota ..	77	90	3·77	—3·80	19	85·8	+1·2	72·7	—0·4	73	88	0·88	—4·63	8
Jaffna ..	74	84	9·83	—7·44	14	82·3	—0·2	71·5	—1·6	68	83	4·30	—6·09	10
Kandy ..	71	89	8·57	—2·13	17	81·5	—0·3	64·3	—1·6	68	86	1·36	—7·51	9
Kankesanturai ..	79	90	22·94	5·80	13	82·3	—	74·1	—	73	78	6·92	—2·82	11
Kurunegala ..	76	95	8·74	—3·65	15	84·3	—1·5	69·2	—1·6	70	93	1·21	—5·57	9
Mannar ..	77	88	5·37	—4·82	12	82·5	+0·3	74·7	—0·2	70	81	2·12	—5·67	7
Nuwara Eliya ..	80	84	6·16	—3·03	17	68·2	+0·5	48·2	—0·8	76	87	1·46	—6·35	11
Puttalam ..	74	88	9·75	—0·38	14	84·6	—0·1	69·7	—1·6	69	90	1·88	—3·67	8
Ratmalana ..	73	90	19·49	+7·37	18	86·8	—	71·7	—	64	85	1·34	—	7
Ratnapura ..	75	93	14·17	—0·62	24	89·0	+1·0	70·9	—0·8	70	90	4·79	—4·33	8
Talawakele ..	87	97	4·55	—	15	71·9	—	54·5	—	80	87	0·90	—	6
Trincomalee ..	74	88	5·24	—8·70	17	80·4	—0·7	75·6	+0·8	73	77	11·16	—1·84	14

SUMMARY

ALTHOUGH THE WEATHER over the Island was unusually dry during the first half of October, a period of very wet weather was experienced from 16th to 21st on account of a low pressure wave near Malabar Coast and a depression in the Bay of Bengal. This rain was mainly confined to the south-western low and mid-country and the southern parts of North-Western Province, so that the rainfall over the rest of the Island, particularly the hill-country and neighbourhood and North-Central Province, was considerably below average. The above rain was consistently heavy in the south-western low and mid-country, where the aggregates for the 6 days at several stations were over 15 inches. The number of daily falls over 5 inches during this period exceeded 75, a large majority of them occurring on the 19th. On account of this rain, many low lying areas in Western Province and Chilaw District were submerged under water, while Kelani Ganga and Kalu Ganga were flooded, the flood waters in the former rising up to the level of a major flood, with a peak height of 8 feet 1 inch on the 23rd. During the rest of the month the rainfall was generally scattered, except on the 31st, when it was moderately heavy and widespread. The greater monthly totals (which occurred in the south-western mid-country) were of the order of 25 inches, the greatest being 37.17 inches at Carney Estate (Palabaddala). Elsewhere in the south-west and in the southern parts of North-Western Province the rainfall ranged from 10 to 20 inches. Over the rest of the Island the rainfall was of the order of 5 inches or so, except at a few stations in the south-eastern low-country, where it was below 2 inches. The rainfall was above normal in the south-western low and mid-country and in North-Western Province, while there were also a few scattered excesses in Batticaloa District and among the Uva Hills. It was below normal elsewhere over the Island. The greater excesses (of the order of 5 to 10 inches) occurred in the south-western mid-country and in the southern parts of Kurunegala District. The greater deficits (also of the order of 5 to 10 inches) occurred in the hill-country and neighbourhood.

Wet weather due to the intertropical front and a depression in the Bay of Bengal ushered in the month of November. Moderately heavy falls of rain were widespread till the 5th. A period of generally fair weather from the 8th was interrupted by occasional thunderstorm activity, particularly between the 18th and 25th. The heavier falls during this period were confined to the south-west quarter and to the hill-country. First signs of the north-east monsoon were evident on the 24th when a few showers were experienced in the East. The end of the month was marked by another depression to north of Ceylon. This resulted in widespread rain from the 30th, with the heavier falls concentrated in the North. This depression caused much damage to houses and plantations in the Jaffna Peninsula. The larger monthly totals of rainfall (which occurred in the south-western mid-country) were of the order of 20 to 25 inches. Totals above 20 inches also occurred among the Haputale hills and in the extreme north of the Island. Elsewhere in the south-west, in Puttalam District and in Jaffna Peninsula the rainfall ranged from 10 to 20 inches. Lowest totals (below 5 inches) occurred in the neighbourhood of Trincomalee and Batticaloa. The rainfall was above normal in the south-western low country, among the Haputale hills and in parts of Jaffna Peninsula and Puttalam District. It was below normal over the rest of the Island, deficits in the north-eastern parts generally ranging from 5 to 10 inches.

Dry weather prevailed over a greater part of the month of December. The only days on which rainfall to any appreciable extent was experienced were the first three days of the month, and the period from 2th to 26th. On the first three days the Island was still being influenced by the depression which caused damage to house and property in the Jaffna Peninsula at the end of November, while the rainfall during the period 24th to 26th was caused by a low pressure wave in the Arabian Sea. Although north-east monsoon weather prevailed during the rest of the month, the rainfall was mainly confined to the north-eastern hill-country. Consequently, acute drought conditions were experienced in those parts of the dry zone, comprising the north-central parts of the Island

and the eastern and north-eastern low-country, as rainfall was well below normal in those regions during the two previous months also. At places like Anuradhapura, Polonnaruwa, Kalawewa and Vavuniya, the rainfall received during October to December (which are some of the rainiest months for these stations) was only about half the average; e.g. the total recorded at Polonnaruwa was 15.13 inches as against an average of 34.35, and at Vavuniya 17.38 inches as against 33.43. During December the larger monthly totals (which occurred in the north-eastern hill-country) were only of the order of 15 to 25 inches. Elsewhere in the north-eastern parts as well as in the southern parts of the south-west quarter the rainfall ranged from 5 to 10 inches. Least rain (totals below 2 inches) occurred in the northern parts of the south-west quarter and in the North Western Province. The rainfall was below normal throughout the Island, deficits at a majority of the stations ranging from 5 to 10 inches.

D. T. E. DASSANAYAKE,
Director.

Department of Meteorology,
Bullers Road, Colombo—7.
January 24, 1956.